AMERICAN ENGINEER
CAR BUILDER AND RAILROAD JOURNAL.

AUGUST, 1896.

THE ALTOONA SHOPS OF THE PENNSYLVANIA RAILROAD.
II.

(*Continued from Page* 93.)

The proceedings of the two conventions held in Saratoga in June occupied so much room in the July number of the AMERICAN ENGINEER as to crowd out the second article on the Altoona Shops. As it was thought that this could be written better on the ground than from notes made during a previous visit, a second journey was planned, partly to escape the heat of New York and to enjoy a sojourn among the hills, where Altoona is located, and also to refresh recollections of the subjects noted in a previous visit. Having a decided aversion to sleeping cars when the thermometer is in the neighborhood of the nineties, the train which leaves New York at 2 P. M. was chosen for the journey. At that hour the thermometer was balancing in the vicinity of 90 degrees or above, and therefore an ordinary coach was taken at Jersey City in preference to a drawing-room car, for the reason that the latter are apt to be insufferably hot in warm weather when they are run in vestibuled trains. In coaches windows are kept open, and a circulation of air is thus obtained, whereas in drawing-room cars there seems to be some reason why the windows must be screened if they are opened, and ordinarily there are only a few screens for the many windows. The coach selected was immediately behind the dining car in the same train. A brisk westerly breeze was blowing into the great trainshed in Jersey City, with the result that the combined odors from the kitchen of the dining-car were wafted into that behind it. This is often, and was then, very disagreeable in vestibuled trains, but is especially so on a hot day. After theorizing about bad smells a good deal the conclusion reached is that there are a great many railroad men who are color-blind in their noses. As evidence of this it may be said in designing drawing-room and sleeping cars, instead of putting the door of the smoking-room toward the end of the car, they are often placed so that they face toward the middle of it, or possibly toward its side, so that when a current of air enters the front end door, as it will when the train is in motion, it drives the smoke from the apartment where bad cigars are consumed and worse stories are told, into the middle of the car. In the much vaunted but viciously ventilated vestibuled trains a carefully constructed conduit is provided which carries the bad smells and the foul air from one end of the train to the other, so that the occupants of the rear cars must breathe a sort of atmospheric hash consisting of the odors of tobacco, multitudinous smells from the kitchen and scullery of the dining-cars, the exhalations from the lungs and bodies of washed and unwashed travellers, and when the latter take their boots off the air literally becomes *fetid*. This conduit is constructed at great expense, it adds largely to the weight of cars, is an obstruction in getting in and out of them, makes the train harder to pull, and forms a sort of trap for collecting microbes and the seeds of disease and death. There are trains of this kind which also run out of the Pennsylvania station in Jersey City, the cars of which are marked "*F. F. V. Limited*," which connect with some of the Virginia railroads. A traveller, who took one of these trains, and found the ventilation very bad, interpreted this lettering to mean "fright-fully ventilated." Our criticism is that vestibules make trains very warm in summer, and that by preventing the escape of bad air, and the entrance of that which is pure between the cars, they make good ventilation more difficult than it is without them; that ingress and egress to and from the cars is more inconvenient than it is when vestibules are not used; they are expensive and heavy, and the advantages do not compensate for these disadvantages. Simple gates in the platforms would make the passage from one car to another secure, which is all that seems to be demanded.

It is not often that any good reason can be found for criticising the Pennsylvania Railroad cars. There is though, it is thought, good ground for finding a little fault with the fastenings of the windows and blinds in some of their coaches. In the first place there is no provision made for holding the window sash or the blind in any position in which it may be desirable to have it. There is but one stop so that the window must be wide open or closed entirely. Often it is desirable to have the sash raised only a few inches, and the blind lowered part way to keep the sun out, but not to obscure entirely the view. The fault with the fastenings is that some of them will not fasten, and one blind could not be moved at all. Surely the mechanical genius of the Pennsylvania Railroad is able to devise something more effective than what they are now using. Of course these are hard times and what with the threats of free silver, bad business and general distrust we probably will be obliged to be content with defective sash locks, at least for the present.

After emerging from Jersey City the first greeting was a prolonged whiff of bad odors from the manure piles on the meadows near the Pennsylvania Railroad shops. One cannot help but drop a word of sympathy for the masters in charge, and the men employed in these shops who must endure the stench which exhales perpetually from this locality. Happily for mankind it becomes accustomed to all sorts of disagreeable things, odors among others, and our friend the editor of the *Master Mechanic* intimates that he enjoys vile perfumes such as tobacco, onions and skunks, and seems to thinks that those who do are in some sense superior to those who do not. The train swung through Newark and then to the real country, which God made, and we soon glided to the leeward of a hay-field, with real hay-cocks, and the aroma of new-mown hay. Thanks to Colonel Waring, the the odor of the streets of New York is not as bad as it was in the days when Tammany held sway, but even now the metropolitan atmosphere in July is not suggestive of perfume, so that the smell of the hay-field, as it was swept into the windows of the car, seemed like incense, and suggested the experience of long ago when hay-making was one of the occupations of the writer and he was free from the drudgery of squeezing ideas out between the nibs of a pen. How fresh and grateful the country looks to one who sees daily little excepting bricks and mortar! In some of the fields the grain was freshly cut, the corn just ready to burst open with its crown of glory, the grass and foliage in its full midsummer luxuriance, and every tree seemed to be clad in coronation robes in honor of us poor mortals who come to look upon them. Verily those of us whose daily lives are spent apart from these glories, of which nature is so lavish, lose much that makes life worth living.

The 2 P. M. train is a fast one, so we were whirled through Elizabeth, with its new elevated railroad above, and clear of the the New Jersey Central crossing where for so many years the only guardian angel who stood between death and thousands of people who traveled on the two roads was a faithful Irishman with a red flag by day and a red light by night. Happily the danger of this grade crossing is now non-existent, and the traveler who knew of it is no longer obliged to hold his breath—as some of us did—every time we reached this dangerous intersection of two roads. Rahway came and vanished. New Brunswick, with the quiet college shades in sight of the road, as we whirled past the old superannuated station: Princeton Junction, with the trees and spires and towers of the seat of learning in view, in the hazy distance, all robed in the panoply of midsummer. To a person who has traveled for nearly half a century by rail between New York and Philadelphia, it is a little unexpected to pass through Trenton without being delayed, and without stopping or being greeted with the cry of peripatetic train boys of "fried oysters and ham sandwiches." The train on this occasion did not stop. Trenton is the seat of Jersey politics and potteries. The train crossed the Delaware River quickly on the strong iron bridge, which recalled the old creaky wooden structure which years ago occupied this

place and had to be crossed at reduced speed, and also brought to mind that it was not very far from the site of the bridge that Washington made that celebrated crossing of the Delaware on a Christmas eve, the sequel to which was of such momentous consequence to all of us.

On the Pennslyvania side of the Delaware the canal and slow-moving boats was suggestive of the past, and a number of bicyles and riders on the tow-path were indicative of the present. The contemplative canal-boat and the ruminant mules made a strong contrast with the alertness of the riders as they appeared in the shaded path which would have made a good subject for a picture representing the past and the present.

In Pennsylvania the well-cultivated fields were soon in view; there were more hay and grain fields, luxuriant corn, market gardens, green trees—beauty, fragrance and delight. The outlying suburbs of Philadelphia, which extend almost all the way to Trenton, with their shops and factories, looked warm and uncomfortable in the July temperature; but the air of comfort of many of the residences is unmistakable. The outlying portions of Fairmount Park were soon reached with its pathetic bronze statue of the wounded lioness, below the railroad the Zoological Gardens, the Art Gallery—a reminder of the Centennial Exhibition—which it seems impossible could have been held twenty years ago, and then a brief stop in the Philadelphia depot, which was hot and stifling, and after the seats were reversed the train was again headed westward.

A glimpse of the well-equipped repair shops of the Pennsylvania road, a rather smoky and dusty ride through the long yard, where there is an ascending grade, extending for some miles beyond, and we come to the matchless suburbs of Philadelphia, where her well-to-do people have made their homes.

A touch of tropical luxuriance seems to be apparent here, if we compare the foliage and the landscape with that east of the Delaware River. The ground west of Philadelphia is beautifully rolling, with groves of magnificent trees—oaks, chestnut and walnut. Some kinds appear here, such as the catalpa, Lombardy poplar, tulip-tree, sassafras, etc., which are not common in New Jersey. Truly it is a goodly land, and those old companions of William Penn acted wisely when they placated the Indians and took up their residence here. The wealth of Philadelphia has been lavished on this region. For a distance of 20 miles or more from the city there is a continuation of beautiful houses with ornamental grounds which nature, art and a protective tariff have combined to beautify. Many of the officers of this great road live in these places, and every facility for getting to and from their homes is given to the residents. Beautiful and convenient stations are located all along this portion of the line, and if the highest achievement of man, as it is said to be, is the creation of beautiful and happy homes, the residents here have certainly accomplished part of that end.

On the date of the journey which is here described the country was at its best. Recent rains had developed the foliage of the trees, the grass and the crops to their full perfection, and the heat of summer had not yet parched or withered any of them excepting the new mown hay. To a tired journalist baked and parched like a ball of pop-corn, and wearied by a metropolitan struggle for existence, the walks, verandas, nooks and shady places and well-made roads looked exceedingly attractive. What capacity for work such daily refreshment must give, what contentment and felicity must come if the household in such houses accords with their external appearance.

After the top of the long grade was reached the shower of cinders was less copious and exasperating. The magnificent view of Chester Valley was then revealed from a high ridge, which had been gradually ascended from Philadelphia. It would require the descriptive powers of Sir Walter Scott or Ruskin to do it justice. Here the suburban residences of city people are no longer seen and the homes of the true rural residents of Pennsylvania are indigenous. The land seems to exude fertility and fatness, and prosperity and comfort are apparent everywhere. In one of the fields a reaping machine was sweeping away the golden grain, a wagon with a typical team of Pennsylvania horses and attendants, fat as the horses, in a grayish afternoon sunshine, the distant hills, hazy and soft in their outline by reason of a light veil of cloud which hung over it all made a beautiful scene. But the accusation of an attempt at fine writing will hold if this vein is continued, and as this article is intended to be descriptive of railroads, and not beautiful scenery or Pennsylvania farms it must be enough to say that the train glided on and on continuously, with only a slow up at a junction, from Philadelphia to Harrisburgh, through the surpassingly fertile and well-cultivated farms of Chester and Lancaster Counties, than which there is perhaps no richer farming land in the world. A brief stop in Harrisburgh after nightfall and the train again sped its way westward. A comfortable dinner in the dining car followed, but observation of the landscape was shut off by the darkness. Dining might be called an excercise of introspection, and to that an hour was devoted satisfactorily. About as much more time elapsed and the electric lights about the Juniata shops came in sight, and we were soon comfortably housed and roomed at the Logan House. Nothing which would interest our readers elapsed between then and the next morning, excepfing that appointments were made to visit the shops and plans were formed for seeing and hearing whatever could be learned and observed that would be likely to interest the reader and the writer.

CLASS L ENGINES.

Our first article on the Altoona shops contained a view made from a photograph of one of the recently built Class L engines, with a view taken at the same time, and on the same plate of a class G engine, built in 1873, which showed in a very striking way the difference in size and appearance of the two engines. It was then promised that a fuller description of the most recent of these would be given. Through the courtesy of the able head of the department of mechanical engineering at Altoona we are able to give the a diagrammatic view on page 168 of one of these engines, of which some thirty or more have been built, and which are giving excellent service, and we are also indebted to the same source for the following data concerning them:

Their cylinders, as will be seen from the diagram, are 18½ by 26 inches; the driving wheels are 80 inches in diameter; the grates 10 feet long, and, as the firebox is on top of the frames, the width inside is about 42¼ inches; the barrel of the boiler is smallest next to the smokebox, where it is 60 inches diameter, from which it tapers backward to a point about midway between the smokebox and firebox, where the tapered portion unites with a cylindrical ring or plate 68 inches diameter. The location of the dome, etc., can be understood more easily from the diagram than it could be from a description.

The fire-box is of the Belpaire type, in the construction of which some important improvements have been made. The crownsheet is flat and horizontal both longitudinally and transversely. In order to allow of the upward expansion of the crown staybolts at the front end the two front rows and some of the ack stay bolts are fastened to the top plate, as shown in the sectional view Fig. 1 herewith, from which it will be seen that a brass thimble is screwed into the roof plate from the outside and the staybolt passes up through this without being screwed into it. A nut screwed on the top end of the bolt rests on a spherical washer, which has a bearing to correspond on the top of the thimble. A cap which covers the end of the bolt and its nut is then screwed in an external thread, on the thimble and serves to make this fastening steam tight. The illustration shows that the bolts are free to move upward, when the firebox is first expanded by the heat, and they are thus relieved of undue strains from this cause. When the shell becomes heated it expands and thus brings the washers to a bearing on the thimble. The ends of the bolts are riveted over the nuts, so as to prevent them from unscrewing. The lower ends of the crownstays are screwed into the crownsheet, but have button-shaped heads below the sheet, with rounded fillets between the heads and the threads on the bolt. Square heads are forged on the lower ends of the bolts to screw them in, but these are cut off after

the bolts are in their position. The other crown bolts have similar fastenings in the crownsheet, but are screwed into the roof-plate and have a cap nut on the outside. The staybolts on the sides of the firebox are located as nearly horizontal as was practicable to permit the inside and outside plates to expand and contract as freely as possible without straining the bolts. The strains to which such bolts are subjected when they stand at a considerable angle to a horizontal line has been repeatedly pointed out, but notwithstanding that fact, the vicious

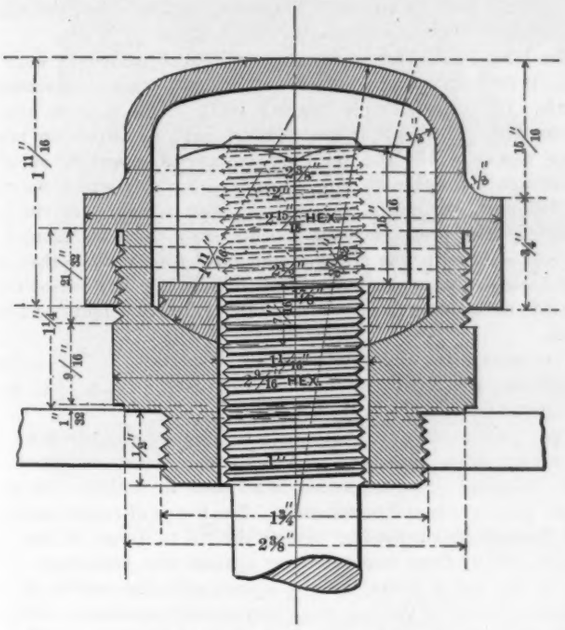


Fig. 1.—Expansion Staybolt.

practice of so arranging staybolts is still continued in many cases. The transverse rods over the crownsheet, which are so essential in the Belpaire boiler, are screwed into the plates and have an ordinary nut on the inside and a cap nut outside.

The water space on the sides and ends of the firebox is four inches wide, but the outside shell at the front end of the firebox is swelled out to the diameter of the largest ring of the barrel of the boiler. The square portion of the outside shell above the crownsheet is somewhat narrower than than the largest diameter of the shell so as to give as much room between it and the cab as possible. What may be called the swollen protuberance of the side sheets, back of the tubesheets, is gradually narrowed or "runs off to nothing" at the back end of the firebox. The object of this lateral extension of the side-plates, back of the tubesheet, is to give a convenient connection with the barrel of the boiler, but chiefly to give more water space between it and the firebox at this point.

The mud ring is double riveted all around. The radii of its inside corners are three inches. This permits the use of a number of rivets in each corner extending all the way through the metal of the ring. The outside contour of the angles of the mud ring are described from the same center as the inside corners are. The through rivets must therefore be radial to the inside and outside curves, and their outside ends are necessarily further apart than the inside ones are. Patch bolts are therefore screwed into the ring and pass through the external plates between the through rivets. The inside end plates have flanges to conform to the corner of the mud ring. The corners of the plates are reduced in radius as they rise above the mud ring and the flanges are made to correspond thereto.

The diagonal braces which are used to strengthen the ends of the firebox shell are attached to the flanges of trough or channel shaped plates riveted to the ends of the external shell. The same sort of attachment is used on the roof for thin braces. They have the advantage not only of providing a good fastening for the braces, but of stiffening the plates to which they are riveted.

The front plate of the shell of a Belpaire firebox is difficult to flange, and has been regarded as a serious objection to the use of this type of boiler. In these engines, instead of making it of one piece it is made in two. The lower part is made in one piece, and extends up on the sides to within about six or eight inches of the center line of the boiler. The top portion is also made in a separate piece and extends down on the sides to within about the same distance of the center line. The cylindrical plate which forms the back ring of the barrel of the boiler is then cut so as to connect these two sections of the end and to the side plates of the shell.

The horizontal seams are all made with butt-joints quadruple riveted. The outside covering plates are 6 inches wide and the inside ones 12 inches by $\frac{3}{8}$ inch thick.

The smoke-box extension is made of a separate plate from the main part of the box. The latter has a wrought iron ring at the front end to which the extension is bolted. This is done so that it can be removed, which is often desirable when work must be done in the smokebox.

The inside arrangements of the smokebox were designed by Mr. Wallace, of this road, and of this we expect to publish an engraving before long.

Especial attention has been given to facilities for washing out these boilers. With this in view besides the ordinary wash-out holes in lower portion of the firebox, three holes, with caps bolted over them are placed in the under side of the barrel conveniently located in its length. The front and back holes are 3 in. in diameter, and the middle one 6 in. Two three-inch holes are also placed on top of the barrel, back of the front tubesheet, and two in the angles on each side of the top of the firebox shell, one pair being near the front on one side and the other pair near the back on the other side. Observation has taught in Altoona, as it probably has elsewhere, that an important element in keeping boilers clean is to have sufficient force to the stream of water which is used in washing out the boilers. Special attention is now given to this, and better facilities are being provided to furnish a water supply of adequate pressure for this purpose.

The grates used in the class L engines are of the finger-bar shaking type. The bars or shafts extend transversely across the firebox, the fingers being 10 inches long measured from the end of one to the end of that opposite to it. The bars, and the spaces between them, are $\frac{3}{4}$ inch wide. At the front end of the firebox there are two dead plates which occupy 33 inches measured in the direction of its length, and back of these is a perforated drop plate 14 inches wide which can be turned so as to dump the fire into the ashpan. The grate-bars are carried on bearing bars of the usual form, bolted by lugs to the bottom of the mud ring. Special pains have been taken, of late, by the authorities in Altoona, to close up all openings around the sides of the firebox so as to exclude cold air from entering at such places. The object of this is twofold, one to keep the cold air away from the fire-box plates, and next to keep the fire away from them, as contact with the cold plates always has the effect of checking combustion. In the class of engines which is here described the bearing bars stand away from the sides of the firebox. In order to close the crevices which are thus left, cast-iron blocks are made which fit in between the bars and the plates, and with a sort of flange or head which laps over the top of the bar. These blocks are simply dropped loosely into the spaces referred to, and the flanges or heads close the openings. In some other classes of engines inclined plates are fastened to the mud-ring and bear against the sides of the firebox, and have joints formed by grooves in the plates filled with asbestos. This makes them almost air-tight.

The check valves are of a pattern designed by Mr. William Wright, chief draftsman, and are inside of the boiler. The valve itself is of a simple conical mushroom pattern, attached to a seat which is removable from the outside. Any injury to the feed pipes outside would not disturb the valve. The horrible accident, which occurred at Pittsburgh a good many years ago, when a whole car full of passengers were scalded, many of them fatally, by the

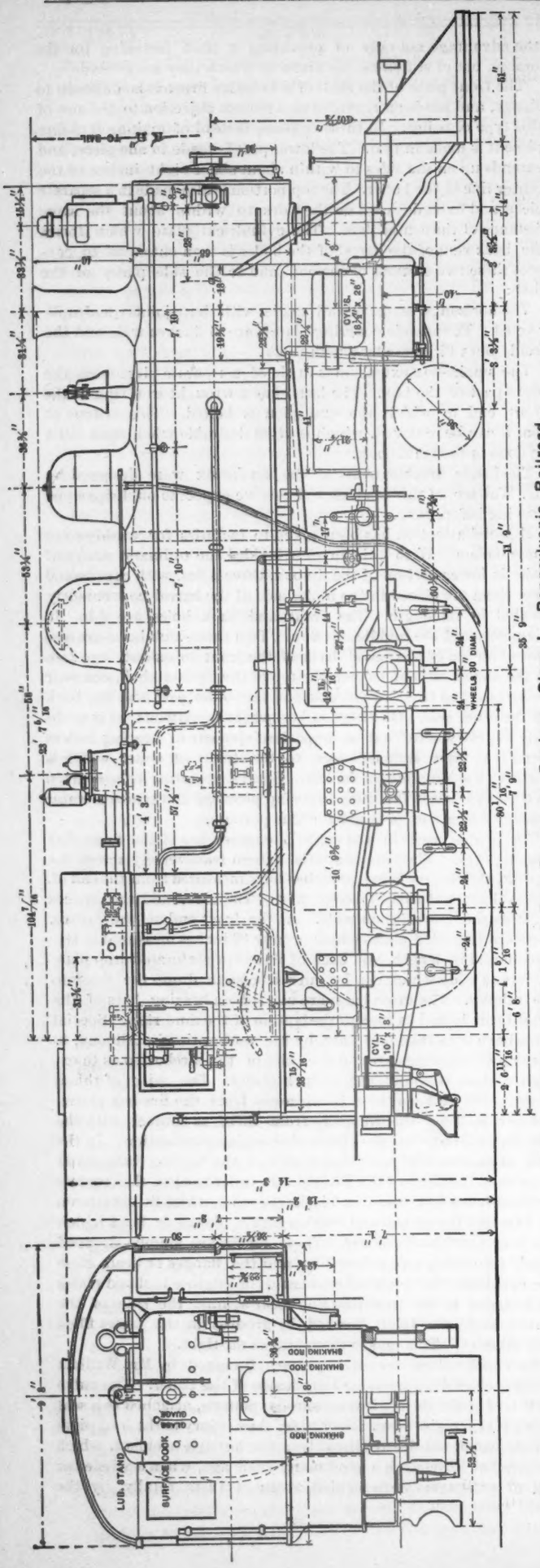


Fig. 2.—Outline Diagram of Fast Passenger Engines, Class L.—Pennsylvania Railroad.

water which escaped from the check valve of an engine, which ran into the rear end of a standing train, has led to the general adoption of inside checks on the Pennsylvania road. The example should be followed by other companies. Another feature, which has been adopted for greater security against such accidents, is cast-iron brackets for running boards. These are made very strong where they are bolted to the boiler, but the projecting part is made with only strength enough to support the loads which they must carry. A comparatively slight blow will break off such a bracket and leave the attachments to the boiler intact, whereas, if a heavy wrought-iron bracket is used, it is apt in a collision to pull out the bolts by which it is fastened to the boiler, and allow the steam or hot water to escape.

The long runs which are now required of passenger engines make it necessary to give especial attention to the oiling arrangements. Of course, ample bearing surfaces are a great help to lubrication. The links in the engines here described are made three inches wide, and they are so made as to provide suitable attachments for oil cups for oiling the pins, by which the rods are attached. Separate oil cups are also attached to the link hangers. The blocks instead of being made with the flanges on one side solid with the block, and a loose plate on the other, are both loose so that when they are worn they can be reversed from one side to the other. They are fastened with two bolts and two studs.

The crossheads and guides of these engines are of a new design by Mr. Vogt, Mechanical Engineer, which we hope to illustrate in a future number.

The piston-rods are fastened to the crossheads with a somewhat obtuse taper and with a bearing against the end of the rod. A rather "cute" expedient is adopted in making the slots in the piston-rods and crossheads. The key is of course tapered, and its back edge must bear against the rod to force it into the socket, and its front edge must rest against the crosshead. The slot in the rod is therefore cut square with the outside of the tapered portion of the rod, and consequently conforms with the tapered form of the key. The form of the back edge of the key slot in the rod does not matter because the key don't touch it. The slot in the crosshead is made square with the axis of the rod, and coincides with the back edge of the key, which stands vertical. The form of the front edge of the key seat in the crosshead is of no consequence because the key don't bear against it. It is therefore not necessary to make either of the slots tapered, which saves considerable work.

The rockers also have some peculiarities. They are made of wrought iron, the shafts being 4 inches in diameter. Between the two arms are two collars which divide the shaft into three parts, the two outer ones alone being used as bearings, which work in bronze bushings made in two parts and held in the rocker-boxes. The collars provide additional end-bearings to resist the wear of the rockers in that direction.

To avoid the awkwardness of making and of handling the lifting shafts when the arms are all forged on, the vertical arm is made separate from the shaft. A circular flange is made on the end of the shaft and is turned up with it. The arm is then bolted to it with six bolts.

The main and coupling rods are fluted, the "big-end," as our English friends call the main stub-end, is of the forked pattern, and the coupling rods have solid ends and bushings.

One of the appliances which is used on these and other passenger engines on this road is the Moran flexible steam joint between the engine and tender, for conducting steam for heating the cars, from the locomotive boiler to the train. This is shown in Fig. 3, which is a view taken from near the ground looking upward from the engine toward the tender. The device consists of a system of ball joints and pipes which form a flexible steam-tight connection, to take the place of rubber hose. Fig. 4 represents an external view of one of these ball joints, and Fig. 5 is a sectional view. The principal feature in this joint, and which has made it successful when other joints have failed, is that it is made with a certain amount of play or looseness, and it becomes steam-tight by the internal pressure bringing the spherical surfaces in contact with each other, and holding them thus, so long as there is any pressure in the pipes. When there is not, there of course is no occasion for the joint being tight. A relief valve

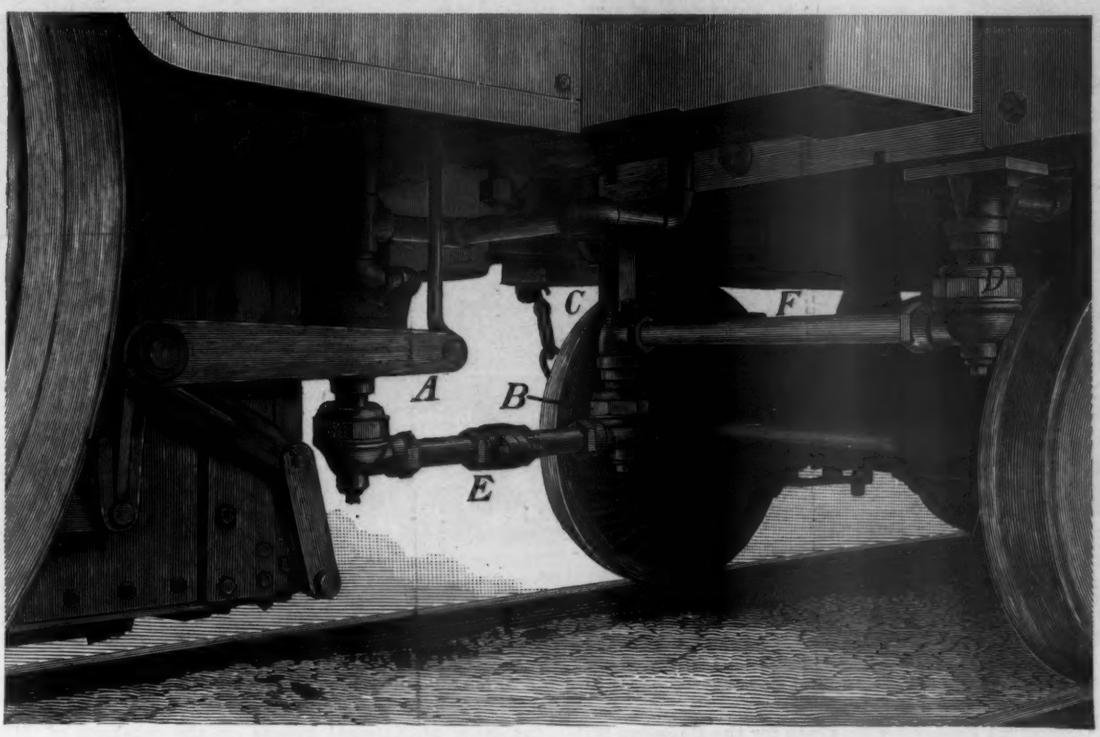


Fig. 3.—Moran Flexible Steam Joint Between Engines and Tenders on Pennsylvanin Railroad.

is shown in the lower part of Fig. 5, which consists of a ball which is raised by a spiral spring below it. When there is pressure in the pipes this ball is pressed down and on the seat below it is then tight, but when the pressure is released the spring raises the ball and allows any condensed water in the pipes to escape. Referring to Fig. 3, *A* is a ball joint connected to a fixed pipe in the engine. *B* is a similar movable joint, which is suspended by links *C* from a trolley above, which has a certain amount of longitudinal movement to compensate for that between the engine and tender. *D* is a third ball joint attached to a fixed pipe on the tender, which extends backward and connects with the train behind it. *A* and *B* are connected together by a pipe *E*, and *B* and *D* by a pipe *F*. As the latter stands crosswise and as *B* can move longitudinally, and all the joints are flexible, it is obvious that this form of connection can adjust itself to any position that the engine and tender can assume on the track when coupled together. This system of connecting pipes has been made a standard on the Pennsylvania road, and, it is reported, is working very satisfactorily, after a test of several years' actual service. The spherical portions are made of cast-iron and no difficulty is experienced in keeping them tight. The manufacturers are the Moran Flexible Steam Joint Company, of Louisville, Ky.

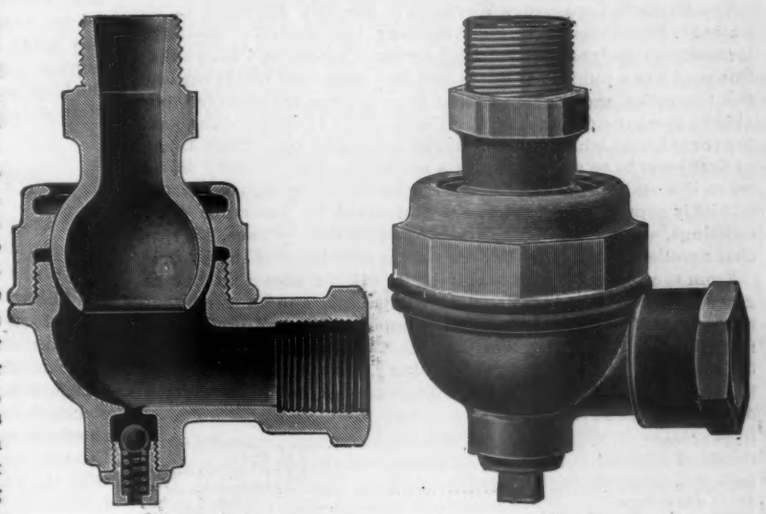


Fig. 5. Fig. 4.

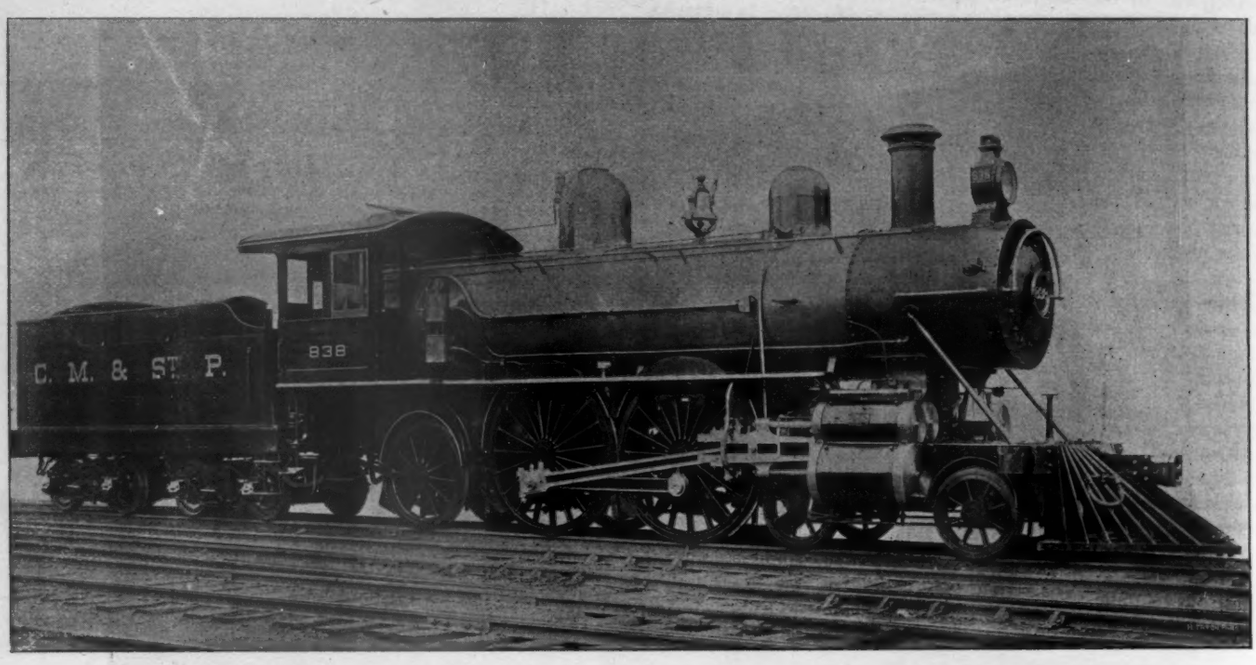
Views of Moran Flexible Steam Joint

In designing the cylinders of these engines care was taken to keep the steam pipes separate from the exhaust pipes, so as to avoid the cooling effect of the latter on the live steam. Ample provision was also made for draining both the steam and exhaust pipes. A cock is connected with the operating mechanism of the cylinder cocks, so that before the latter are opened the steam pipe can be drained, and it is kept open as long as the cylinder cocks are.

The driving springs as shown by the diagrammatic view are underhung, the firebox being on top of the frames. Liberal sized steps are provided on both the engine and tender, with very conveniently located handholds on both. The arrangement of throttle lever is a little peculiar. As will be seen from the diagrammatic view, there is the usual throttle lever back of the firebox. As the engineer occupies a position on the side, it is desirable to have the lever farther forward. A horizontal shaft, shown in the diagram, is therefore placed on the top of the firebox, which has a vertical arm located in the transverse center of the engine, and is connected with the throttle lever by a rod. On the outer end of the shaft there is a pendent lever, with a cranked handle or the engineer.

The appearance of these engines is very impressive. As shown in the diagram, the centers of the boilers are 107½ inches above the rails. They are of large diameter, so that the body of the machine is high and the Belpaire firebox adds to the massiveness of its appearance. The engines have been doing excellent service and reflect much credit on the designer. As mentioned in our first article, they weigh 134,500 pounds, and carry 185 pounds of steam pressure per square inch.

(To be continued.)



Vauclain Compound Passenger Locomotive for Chicago, Milwaukee & St. Paul Railway.

Vauclain Compound Passenger Engines for the Chicago, Milwaukee & St. Paul Railway.

The Baldwin Locomotive Works have recently delivered to the Chicago, Milwaukee & St. Paul Railway two powerful passenger locomotives designed for service between Chicago and Milwaukee. The road has a number of heavy and fast passenger trains between the two cities, and we believe that these engines are expected to be able to cover the distance of 85 miles in about 1½ hours when hauling these trains, which often comprise ten heavy cars. This does not at first seem to be as remarkable a performance as it really is, but when it is stated that the first four miles out of Chicago is through a thickly populated district and is obstructed by numerous grade crossings, so that 10 minutes are allowed for this distance, it is clear that excellent work must be done for the remainder of the journey.

From the accompanying engraving it will be seen that the engines are four-cylinder Vauclain compounds, and in general arrangement of running gear resemble some other express engines recently built by the Baldwin Works. The engines are remarkable for their great boiler power, there being 2,244.5 square feet of heating surface and 30.2 square feet of grate area in each. The principal dimensions are as follows:

Gage of road	4 feet 8½ inches
Cylinders diameter	H. P. 13 L. P. 22. Stroke 26
Driving wheels	78 inches diameter
Total wheel base	25 feet 6 inches
Rigid " "	13 " 9 "
Driving " "	6 " 9 "
Weight, total	140,700 pounds
" on drivers	71,600 "
" " trailing wheels	29,100 "
" " truck	40,000 "
Boiler diameter	60 inches
Number of tubes	264
Diameter of tubes	2 inches
Length of tubes	15 feet
Fire-box, length	103⅜ inches
" width	42⅛ "
" depth	71¼ inches front 69 " back
Heating surface, firebox	171 square feet
" " tubes	2,073.5 " "
" " total	2,244.5 " "
Driving wheels, diameter	78 inches
Truck wheels diameter	36 inches
" journals	5½ inches by 10 inches
Trailing wheels, diameter	54 "
" journals	7 inches by 12 "
Tender tank capacity	4,500 gallons
" wheels, diamcter	33 inches
journals	4½ inches by 8 "

On July 10, one of these engines (No. 839) made a good run from Chicago to Milwaukee. It pulled train No. 23, which leaves Chicago at 3 p. m. and has a schedule time of 1 hour and 55 minutes. Two stops are made by this train, one at Western Union Junction and the other at National avenue in the outskirts of Milwaukee. On the trip alluded to the train consisted of 14 cars, as follows: Four baggage and express cars, four coaches, four drawing-room cars, and two sleepers. The total weight of the train back of the tender was considerably in excess of 500 tons. Notwithstanding this heavy load the engine made schedule time, and made up five minutes lost at Western Union Junction through some delay with the baggage. At some places a speed of 80 miles per hour was maintained for a number of consecutive miles.

Engine Power and Self-Propelled Road Traffic.

Sir David Solomons has an article in the *Engineer*, under the above caption, in which he gives some figures on the power required in self-propelled road carriages. From his article we take the following:

A vehicle which will travel at a given speed, say of 12 to 14 miles per hour, no matter whether the country be flat or hilly, is a great factor in annihilating space.

Before my steam carriage with the Serpollet boiler was constructed, I was anxious that a series of calculations and experiments should be made in order to be fairly sure, in advance, that the result I sought was likely to be realized. The results are closely in accord with the experiments I made at an earlier date, and it may be of interest to those engaged in the manufacture of these carriages to have some information on the subject. In giving the figures, I take round numbers, which are quite close enough for all practical requirements.

I assume the carriage to weigh 2¼ tons when laden, then on a good level road a speed of 7⅛ miles per hour can be obtained for 2½ horse power, and on a bad level road for 4⅛ horse power. To travel up an incline of 1 in 20 on a good road at the same speed would require 10 horse power, and on an incline of 1 in 10 on a similar road about 19 horse power would be necessary. It will be noticed from these figures that each succeeding horse power necessary is practically double the preceding one. It will also be observed that the increased power required between a level road and an incline of 10 per cent., which is not uncommon in many districts, is practically as 1 to 5.

From these figures it is obvious that in order to travel at so slow a speed as 7⅛ miles per hour, whether on the level or a hill of 10 per cent. rise, in the case of a carriage weighing 2¼ tons, when provisioned and laden, the vehicle must carry an engine capable of giving up to, say, 20 horse power. If a speed of 12½ miles per hour on a good road is sought, nearly 4 horse power is necessary; on a bad road 7⅛ horse power; on a 1 in 20 incline, 16⅜ horse power;

on a 10 per cent. incline, roughly, 30 horse power. For a speed throughout at the rate of 15½ miles per hour on a good level road, about 5 horse power is necessary; on a bad road, 9 horse power; on an incline of 1 in 20, 20 horse power; and for an incline of 10 per cent. rise, nearly 40 horse power.

If the weight of the vehicle when laden was, say, 1 ton; the horse power necessary for similar speeds would be two-fifths of the figures given above. This I mention, because 1 ton is approximately the weight of most petroleum motor driven carriages when laden.

If it now be desired to travel on the level and up hill at an unvarying speed of, say 12 miles per hour, such a carriage should carry an engine capable of giving from 2 horse power up to 12 horse power. Since the majority of the carriages in question are fitted with engines incapable of giving more than 4 horse power, the desired uniform speed of 12 miles per hour will, therefore, be reduced to one-third, viz., four miles per hour where a 10 per cent. incline is reached. This is what they realize in practice, and may be taken as a very good proof that the figures I quote are approximately correct.

The general analysis given above is instructive, for the reason that it teaches two important facts which are essential when a given average speed is required: (1) That no vehicle is of much service for heavy work unless an engine capable of giving out not less than 30-horse power is fitted; (2) that for light traffic the engine should give not less than 12-horse power for the maximum.

That both these conditions can be fulfilled with steam has been proved, but in the case of petroleum-driven motors I do not think that the result has yet been satisfactorily obtained. To increase the power of the latter form of engine threefold means in practice that its weight would be at least twice as great, and that more water would have to be carried for cooling the cylinder or cylinders, water in all probability being lighter than any form of cooling apparatus to do the equivalent duty. It is, therefore, clear that if the petroleum motor is to be heavier, the first conditions stand altered, and in consequence of the carriage being heavier, the speed will be reduced, or a still larger engine must be carried.

I therefore conclude, in the present state of our knowledge, that if the light petroleum-driven carriage is required to run at an average speed of 12 miles per hour on good and bad roads, where inclines exist up to a 10 per cent. rise, the carriage laden will probably weigh not less than 1½ tons and require a maximum of not less than 18 to 20 horse power.

The *Aluminum World* gives the following rules with regard to obtaining the best castings with aluminium bronze. An essentia point is the special care to be taken not to overheat the metal, for if it be heated to too high a temperature, the aluminium will oxidize, the oxide which is thus formed making the entire casting "dirty"; the metal will also be spongy from the presence of large amounts of occluded gases. The scum, which floats on top of the melted bronze in the crucible, must be prevented from going into the body of the casting. The greatest trouble in making bronze casting, however, arises from the great shrinkage of the metal, a difficulty which is overcome if the casting have a large sinking head and "risers," it being necessary, however, in many cases to make the sinking head fully as large as the casting.

In the latter part of June the *Lucania*, of the Cunard line, and the American built *St. Paul*, of the American line, made remarkable western trips across the ocean. The *Lucania* averaged 21.37 knots per hour for the entire distance, 2,855 nautical miles, while the *St. Paul* averaged 20.58 knots for the distance covered by it, namely, 3,113 nautical miles. The best day's run of the former was 562 knots, and of the latter 540 knots. These speeds are enormous, being about 28 and 26 statute miles per hour respectively, maintained for 24 hours. The *Lucania* has about 30,000 horse power and the *St. Paul* nearly 22,000. Consequently, with about 40 per cent. more power, the British boat made only about 4 per cent. more speed. Of course the British boat is the larger, but there is not enough difference in tonnage to account for the difference in performance. The greater coal consumption of the Cunarder, amounting in all probability to at least 150 tons per day, and the greater cost of operation attendant on the larger boat, may have their effect in deterring other lines from attempting a speed of 23 knots, though the new North German Lloyd boats are to have a horse power of 28,000.

The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes.*

BY M. L. TOLMER, SUPERINTENDENT OF THE SHOPS OF THE EASTERN RAILROAD OF FRANCE AT MOHON (ARDENNES).

The substitution of iron sections for wood in the construction of cars date on the Eastern Railroad of France from the year 1861. From 1861 to 1866 about 1,840 cars, 4.8 metres (15 feet 9 inches) long over the bodies, and designed for the transportation of coal (known as series L) were built with the upperframes,† or frames of the box, of iron. By this innovation the weight of these cars was reduced to 4,300 kilograms (9,460 pounds), while the weight of similar cars of wood was 5,000 kilograms (11,000 pounds).

The endeavor to reduce the dead weight, the difficulty of procuring large and long timbers free from defects, the high price of such timbers and the progress in metallurgy which permitted the production of iron sections of exact dimensions all led to the employment of iron in the construction of rolling stock. It was with such ideas as these that there was built in 1865 the first cars having mixed underframes, that is, frames partly of iron and partly of wood, the sills which the pedestals were attached being of I or channel sections 250 millimetres (9.6 inches) high.

M. Boutard, Engineer of Rolling Stock on the Eastern Railroad, in 1868 designed a car of 10 tons capacity, provided with high sides (for the transportation of coal and coke) of which the underframes and upperframes were entirely of iron. This car, quite remarkable for that period, was made 5.5 metres (18 feet ⅛ inch) long over the body. It weighed empty only 5,320 kilograms (11,700 pounds), and combined lightness and strength to a greater degree than similar cars with wooden or mixed frames already in existence.

From the beginning of 1869, all the cars of the company have been built with the underframes of iron, and the uncovered freight cars having high sides (series L and H) have had the upperframes of iron also. With the inauguration of these designs the length of the car bodies have increased, until to-day they have attained a length of 7 metres (22 feet 11½ inches) for cars in regular service, while this figure has been exceeded considerably in special cases.

Certain other companies, for various reasons, have gone much further in this direction, and have adopted types of cars in which the entire box or superstructure is of iron. The Eastern Railroad itself possesses 120 cars (series U and U¹) purchased from the Com panie Léronville-Sedan, which conform to these types, the flooring alone being of wood.

The Eastern Railroad possessed on December 1, 1895, a total of 28,504 cars, as follows:

7,613 cars with underframes and bodies of wood.
1,880 cars with underframes of wood upperframes of iron.
3,249 cars with mixed underframes and upperframes of wood.
1,276 cars with mixed underframes and upperframes of iron.
14,366 cars with iron underframes and of which 3,761 also had iron upperframes.‡
120 cars with iron underframes and entire box of iron.

Without dwelling upon the great progress realized in construction by the employment of metal parts, we will at present discuss the life which it is reasonable to attribute to these cars, and estimate under several conditions varying with the time, the expense involved in their current repairs.

In the study of this question of great interest, which was intrusted to us by M. Salomon, Engineer in Chief of Material and Motive Power of the Eastern Railroad, at least in respect to the rolling stock of that company, we have taken apart and examined, piece by piece, a certain number of cars built in the earlier years. Each piece was weighed, after having the paint and rust removed from its surface by scraping and brushing. Moreover, the exact outlines of the various sections were determined where the wear or loss from rust had been great or was of special interest. The weights obtained have been compared with the weights of the same parts when new, to determine the proportion of metal lost. In making this comparison we have had at our service sections of the same dimensions found in the storehouse.

---

*Translated from the *Revue Generale des Chemins de Fer*.

†All the cars here considered are carried on four wheels and are of a type resembling the flat-bottomed gondola cars in this country. By upperframes is meant the frame or skeleton of the sides and ends which form the box.

‡ Of 4,793 passenger cars owned by the company, 1,183 have wooden underframes, 471 have mixed underframes, and 3,139 have underframes entirely of iron. Of 1,374 cars partly owned by the company, 280 have wooden underframes, and 1,094 have underframes entirely of iron.

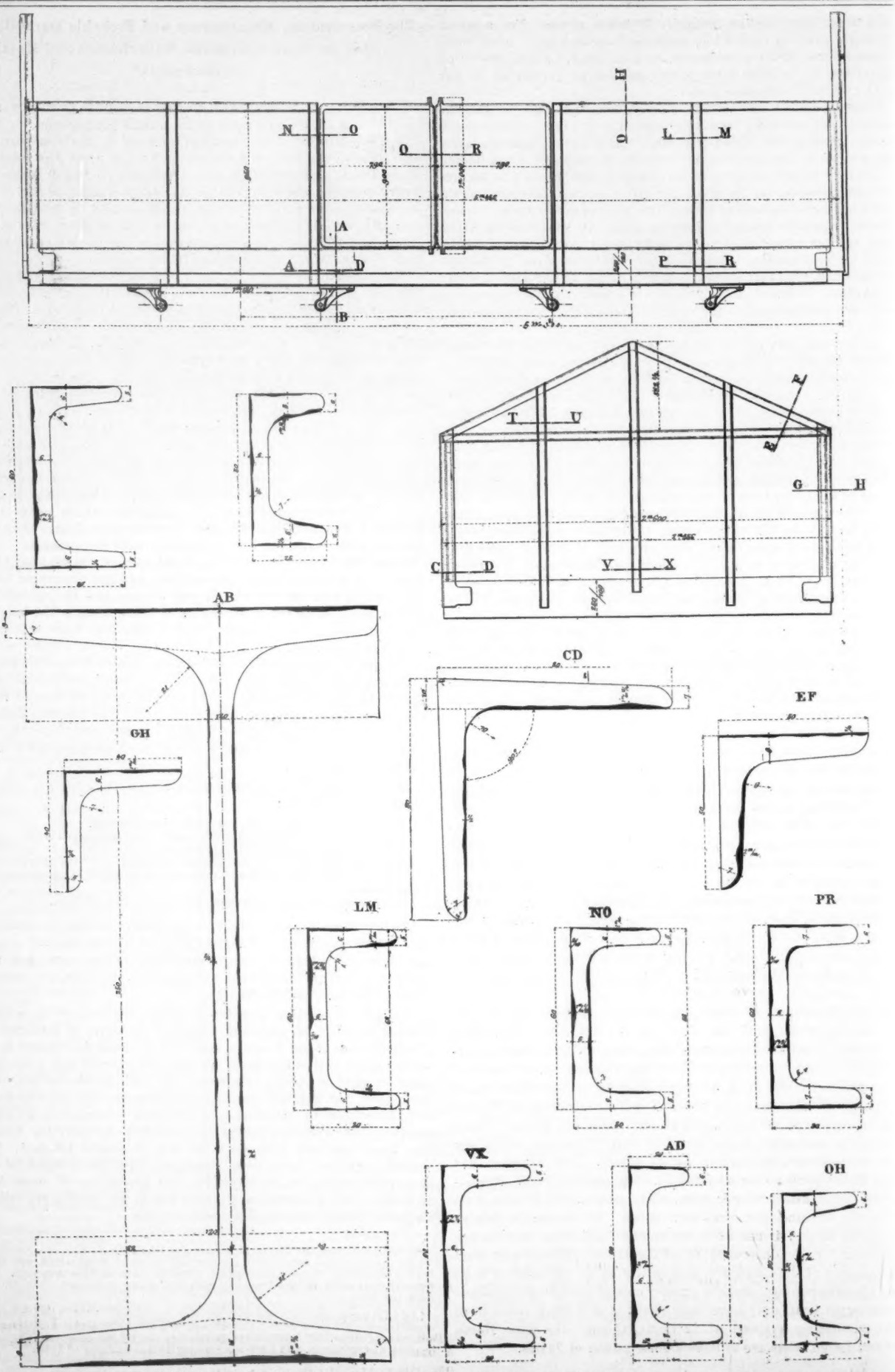


Fig. 2.—Side and End Elevations and Sections of Iron Members of Cars with Mixed Underframes and Iron Upper Frames Built by the Eastern Railroad in France in 1865.

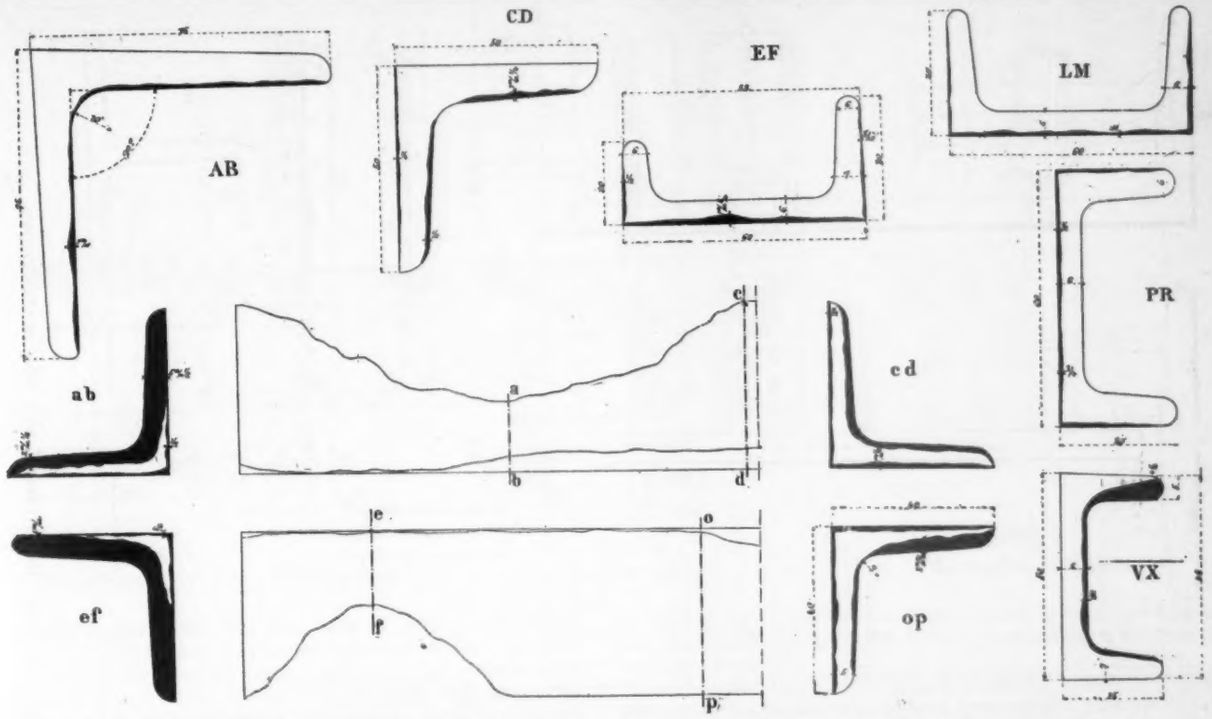


Fig. 1.—Sections Showing Corrosion of Steel Upperframes on Cars Built by the Eastern Railroad of France in 1861.

NOTE.—Ca s were somewhat similar to design shown in Fig. 2, but had wooden underframes. A B is section of outside angle at corner post; a b is a section of the inside angle at corner post; C D is section of angle at top edge of end of box; E F is section of a side post; L M and P R are sections of end posts; and V X is a section of top edge of side of box.

The cars subjected to this examination belonged to the following six types, representative of four distinct epochs in construction:

1st. Cars of series L, constructed in 1861, with underframes of wood, and upperframes of iron.
2d. Cars of series H, constructed in 1865, with mixed underframes, and upperframes of wood;
Cars of series L, constructed in 1865, with mixed underframes, and upperframes of iron.
3d. Cars of series H, constructed in 1869, with iron underframes, and iron upperframes;
Cars of series L, constructed in 1875, with iron underframes, and iron upperframes.
4th. Cars of series U, constructed in 1874, built entirely of iron except the flooring.

All of these cars examined have been selected because they have not at any time been subject to modification or to extensive repairs, and have not had new parts substituted for those entering into the original construction, and because they have not suffered accidental damage more severe than they would receive in ordinary service.

CARS WITH WOODEN UNDERFRAMES AND METAL UPPERFRAMES.

The cars having their underframes of wood and upperframes of iron were built in 1861; they have consequently been in existence about 34 years. Many have already been demolished, the underframes having become useless for further service and the iron upperframes having suffered so much from oxidation as to be beyond repair. We have, in particular, examined car L 28,099, some of whose sections are given in Fig. No. 1. The areas shown in black indicate the metal lost by corrosion.

It is shown by this examination that the oxidation caused a loss of 6.04 per cent. of the weight of the frames. Unfortunately the corrosion occurred principally at certain points that affected greatly the strength of the structure, particularly in the angles girdling the sides and ends at the top and the angles in the interior of the corners, nearly all of which parts at the present time require to be replaced as the cars come into the shops for heavy repairs. The expense under this head amounts to about 25 francs ($5) per car.

Probable Life.—It is admitted that for these cars the metal upperframes in general have no greater life than the principal parts of the wooden underframes. We have no further knowledge that would justify a systematic restoration of this type. By the retention of the best of the iron sections still in service and the use in repairs of those parts still fitted for service, obtained from cars broken up, it has been possible to prolong the existence of a certain portion of the series for a period of half a score of years. Up to that time the cars decayed successively by reason of the general corrosion of the metal upperframes, and of the bad condition of the wood underframes.

To sum up, while the adoption of iron upperframes makes a lighter car than when wood is employed, the life of the car is not materially increased. Its life varies from 30 to 40 years.

CARS WITH MIXED UNDERFRAMES.

We have examined cars with mixed underframes, numbers H 11,921 and H 12,213, having the upper frames of wood, and the cars, L 29,834, L 29,856, and L 30,314, having metal upperframes (Fig. 2). These were constructed in 1865, and are 30 years old.

The Underframes.—The sills of the frames upon examination were found to have lost 3.35 per cent. of their original weight. The loss is from the entire inner faces of the I-beams where the surfaces have seldom been painted, and from the surfaces covered by other parts. It is at the spring suspension attachment to the frame that the corrosion is most easily seen, but at no point has it become so great as to lead one to question the safety of the piece.

Upperframes.—The loss from the members of the iron upper frames of the cars of series L (series H are of wood) is much greater than the loss from the sills, particularly in the case of such parts as are situated inside of the box, or are covered by the wooden flooring. The average loss from rust was 4.32 per cent. In no one part had it become sufficient to require the replacement of the member.

Rivets and Gussets.—The riveting in these cars is of comparatively little importance, as it is employed only in the assembling of the frames to keep the end sills and intermediate crossties square with the longitudinal sills. We estimate the number of rivets in doubtful condition at 15 per cent., due either to the rivets being badly placed at the beginning, the iron being burned or too cold, or because the metal was brittle through bad work or inferior material. In all cases the loss of metal from the heads by corrosion is not serious, and the loosening of the rivets by shocks and vibrations is absolutely imperceptible.

The brackets uniting the intermediate crossties with the longitudinal sills are still in a satisfactory state, but a great number of gussets uniting the end and longitudinal sills had to be replaced repeatedly because of breakage in regular service.

Probable Life of the Cars.—In the cars with mixed underframes it is considered that the iron sills are yet good for a period at least equal to the time they have been in service, which would give them a total life of, approximately, 50 to 60 years. Concerning the metal upperframes of the cars in the series *L*, it is considered, after com

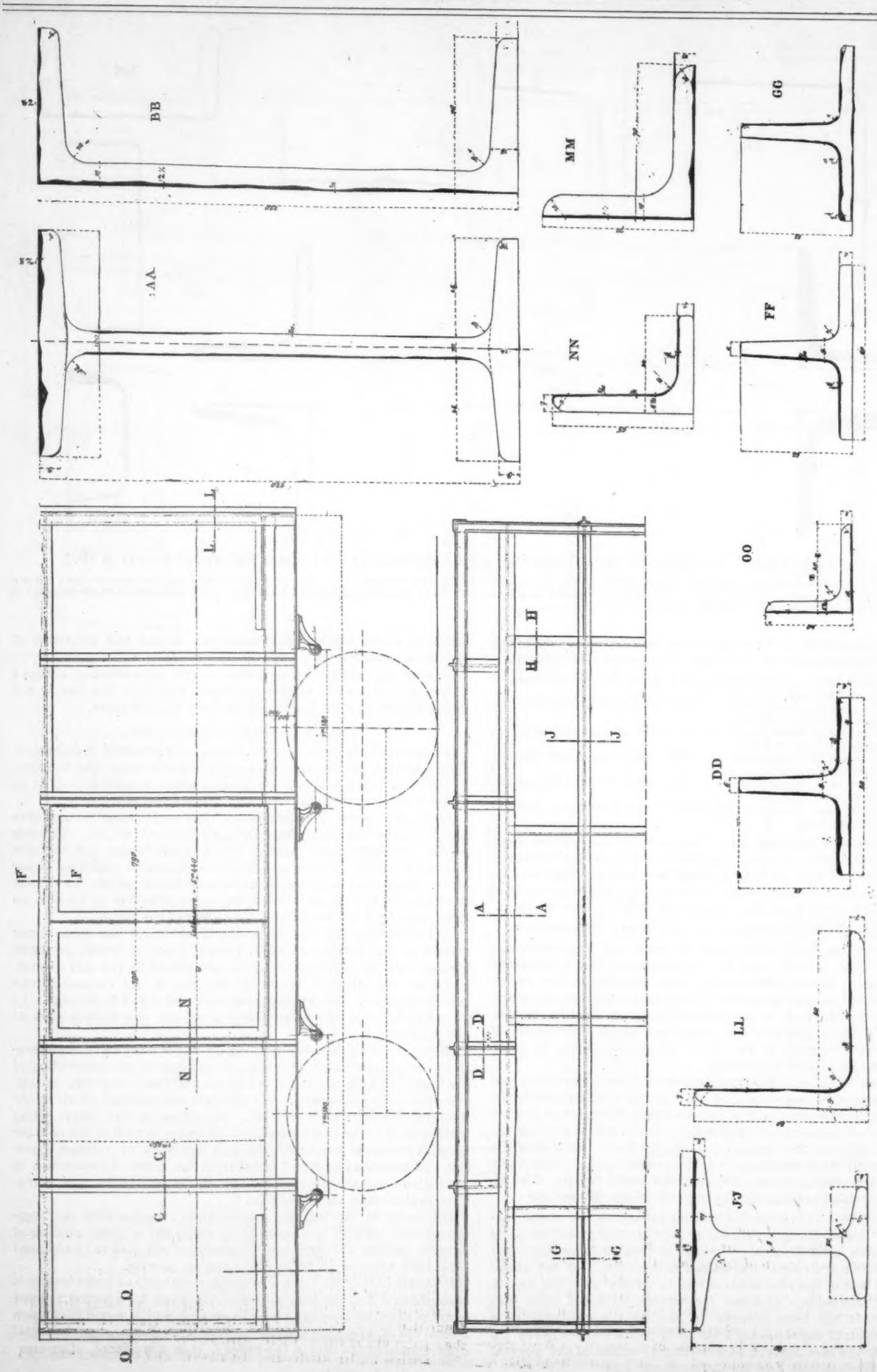


Fig. 3.—Elevation, Half-plan and Sections Showing Corrosion of Iron Members of Cars with Iron Upperframes and Iron Underframes, Built by the Eastern Railroad in France in 1869.

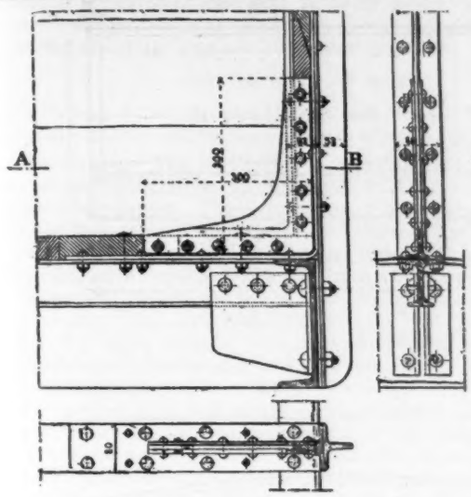


Fig. 5.
Old Construction on Cars Built in 1869.

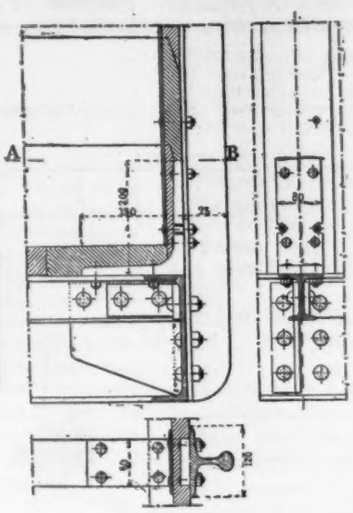


Fig. 6.
New Construction.

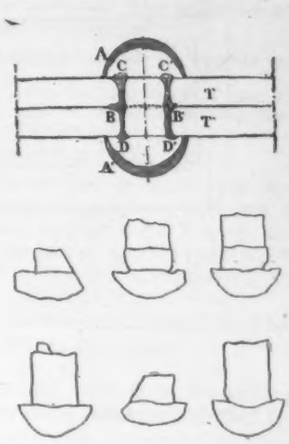


Fig. 7.
Corrosion of Rivets.

parison with similar parts of the cars built in 1861, that in four or five years it will be necessary to commence renewing some of them. By following, in the repair of these upperframes, the same method of procedure as for the cars of the year 1861, the condition of the underframes being first considered, it is believed that by spending the small sum of 25 francs ($5) on them, the box or superstructure of the car will be good for from 10 to 15 years more of service. We estimate that at the end of that period it will be necessary either to make a new box or destroy the car. It will at that time have had a life of from 45 to 50 years, which period can be extended to 55 or 60 years by the expenditure of about 270 francs ($54).

CARS WITH IRON UNDERFRAMES AND IRON UPPERFRAMES.

We have examined cars Nos. H 13,305 and H 13,748 built in 1869 (Fig. 3) and having therefore been in existence 26 years, and the cars L 27,621 and 30,582 built in 1875 and consequently 20 years old.

Underframes.—The loss from the iron members amounted to about 6 per cent. for the materials put in service in 1869 and 3.18 per cent. for those of 1875. It appears again, therefore, that the action of the rust is not proportional to the time, but increases more rapidly than the time. Nevertheless, it is acknowledged that in these particular cases the loss is not yet important enough to call for the replacement of any parts; and that, on the other hand, an important point relative to the losses by corrosion is the fact that in cars of the series H (year 1869) there is one more intermediate crosstie, providing relatively more small iron work on which corrosion can act.

As in the case of the mixed underframes the loss of metal from the sills is all from the interior surfaces and those surfaces covered by other parts, notably at the top of the spring suspension brackets The same observation is true of the end sills.

In respect to the iron floor stringers and the intermediate crossties these are corroded somewhat on all their faces, and in a manner proportionately more important than on the sills. These facts are an evidence of the enormous influence of the paint in preserving the iron parts of the underframes.

The Superstructure or Box.—The loss from the iron upperframes in the series H, type 1869, was about 5 per cent. In this, as in other cases, it is the metal parts inside of the box which have suffered most, particularly the gussets holding up the end posts as shown in Fig. 5. Generally these gusset plates which are only 6 millimeters (about $\frac{1}{4}$ inch) thick are so weakened that their replacement is necessary. We will also, hereafter, substitute for this assemblage of parts, which is somewhat complicated, a design analogous to that of the construction shown in Fig. 6. This modification consists in substituting for a T-iron upright or post one of a rail section and securing it by a forged knee or bracket. In our opinion, when this modification becomes general the design of the upperframe leaves nothing to be desired. The work of changing costs 150 francs, ($30) per car.

Rivets, Gussets, etc.—The iron underframes, types 1869 and 1875, it seems to us, should decay first of all about the riveting, although on four cars examined only two rivets were lost, and 10 others were loose in the holes. A separate examination of the rivets show that the corrosion is generally as indicated in the upper part of Fig. 7. One-half of the rivets have lost 15 per cent. in weight, there being a large loss at BB', probably due to the accumulation of moisture between the parts TT'.

It is clear that machine riveting, particularly hydraulic riveting, by bringing the plates together with force at the moment of driving the rivet and in making the rivet fill the hole well reduces greatly the chances for rust at B, C and D, but in the old material riveted by hand it is to be feared that in several years the surfaces CC' DD' will have continued to corrode, and many rivets will be found loose in their holes, as we have established in a score of cases

The heads AA are all more or less eaten, but it does not appear that at present they are likely to cause the loss of the rivets.

If it is considered that the oxidation of the rivets is of sufficient importance to cause solicitude, care should be exercised in the building shops in keeping the cupping tools of the riveters in shape, and guarding against the disposition of the men to repair these tools themselves, as they will grind the faces or edges, finally giving forms of rivet heads that are too much flattened.

We conclude from the results of our observations that the rivets in these cars will exhibit the defects enumerated above in the following order:

1st.—Rivets holding together the smaller parts of the upper framing. (Generally speaking these rivets are very strongly attached by corrosion; many have already been replaced in the course of current repairs and others will be as the cars enter the shops for repairs).

2d.—Rivets in other parts of the upper frames—those which hold together the heavier parts of the frame.

3d.—Inner rivets in the gussets securing the angles of the underframes, and rivets holding the angle iron floor stringers to the intermediate crossties.

4th.—Rivets holding the guard plates, the corner irons—holding the crossties to the sills—and those securing the plates to which the drawgear is attached, etc.

The rivets in the second and third categories will be found in a poor state of preservation; we estimate that it will be necessary to replace regularly 50 per cent of the former and 25 per cent. of the latter in each passage of the cars through the shops for heavy repairs. With this precaution, of which the cost is about 8 francs, ($1.60) per car, the riveting of the iron underframes of these cars will suffer very little from wear and rust for a score of years. The rivets in the fourth category require as yet no attention.

The plate iron gussets have experienced a loss estimated at more than 18 per cent. of their weight. Nevertheless, as they were originally very heavy and the oxidation is chiefly outside the lines of rivets, it is to be presumed that these parts have a life equal to that of the frame as a whole.

Probable Life.—All these precautions will likely contribute to the prolongation, without accidents, of the life of these cars through a period equal to that already passed since their construction, thus assuring them a total existence of about 50 years. It appears certain that this life can be considerably increased by exercising care to prevent the action of rust.

From an examination of cars constructed in later times, it is found that the interior surfaces of the underframes commence to lose their paint at the end of three years of service. It is only then that rust begins to be produced. To avoid the rust, then, the frame

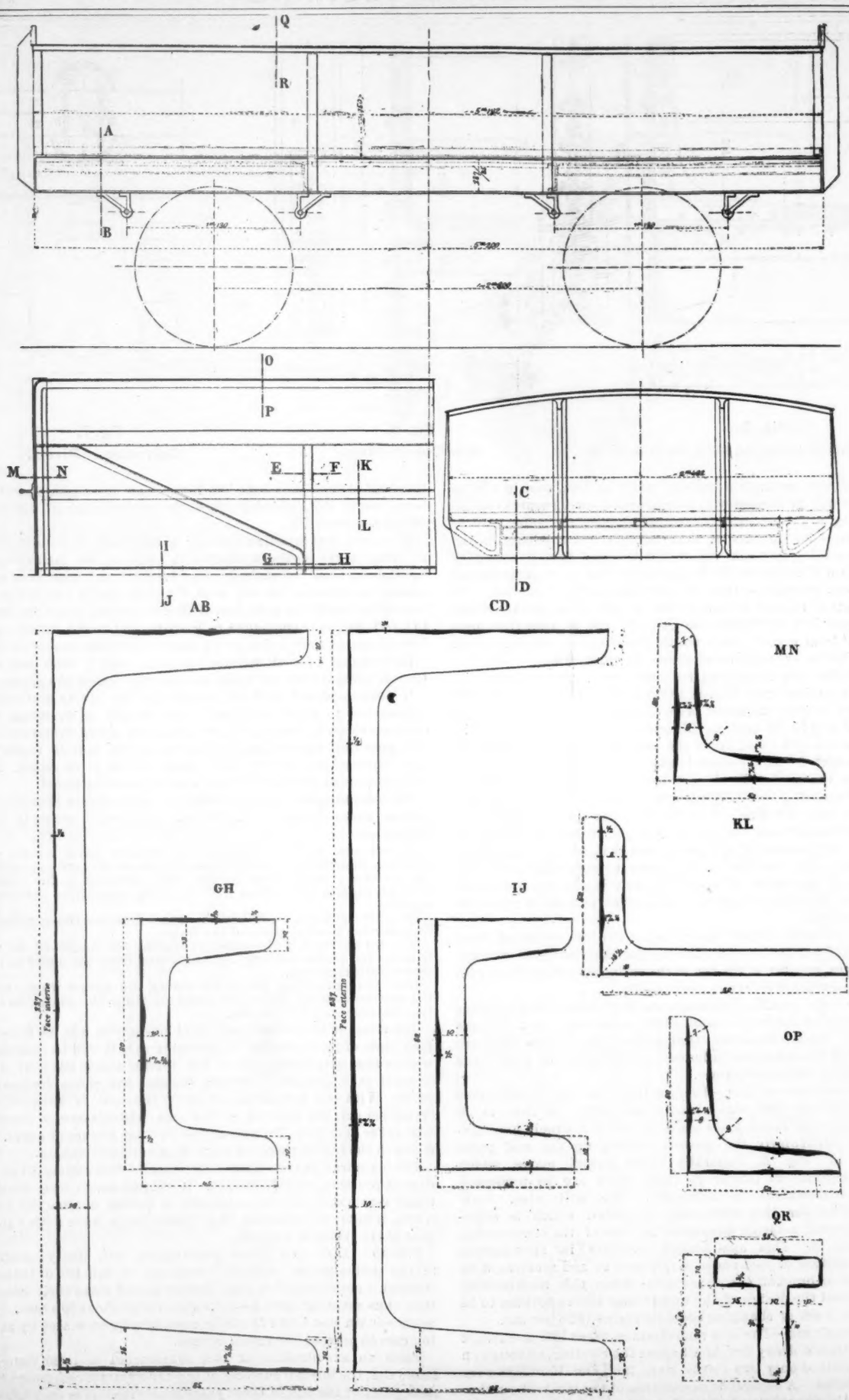


Fig. 4.—Elevation, Quarter Plan, End View and Sections of Members of Cars Built Entirely of Iron, by the Eastern Railway of France in 1874.

should be repainted at least once in three years. This operation, with at least two coats on the iron, will cost about 17 francs ($3.40) including material, labor and all general expenses.

CARS ENTIRELY OF IRON.

We have examined the cars U 25,909 and U 25,962 (Fig. 4), which were built in 1874, and are consequently 21 years old.

Underframes.—The iron sections entering into the construction of the underframes have lost about four per cent. of their weight by oxidation. The corrosion is of much the same nature as in the frames built in 1875 and noted above. The examination of individual sections reveals no cause for immediate apprehension.

Superstructure or Box.—The loss from the iron plates forming the sides and ends of the box is only 1.8 per cent., and is therefore very small. The loss from the special iron sections constituting the upper frames (or frames of the box) is about 12.5 per cent., which is considerable and is explained in part by the fact that the sections are very light. We should probably attribute this to the fact that iron plates cover them and that these plates have a long life. In fact, in the case of the boxes with wooden sides, the friezes being often renewed, the irons are frequently exposed and at such times are painted, which added to their life.

The experience with the cars with boxes wholly of iron has led, then, to the singular conclusion, that the decay of these boxes is due to the destruction (by rust) of the upper frames, and it seems probable that these iron members will have to be replaced from time to time, and this work has already begun after a service of 20 years, and when the plates forming the sides and ends are yet good over all their outer surfaces.

There is a call then in cars of this type, even more than in the cars with wooden sides and ends, to employ in the framework iron sections of large dimensions.

Rivets, Gussets, etc.—The rivets of the underframes of the cars in the series *U* were found in practically the same condition as those the iron frames of the cars built by the railroad company, and require the same care. This cannot be said of the rivets in the superstructure having their heads inside of the box, where they are most strongly attacked by rust; 35 per cent. of these have to be replaced each time the cars undergo heavy repairs.

REMARKS ON ALL TYPES OF CARS.

We have considered only the types of cars designated by the letters *L*, *H* and *U*, which are specially designed for the transportation of coal and coke. All of the other types—covered cars, series *N*, *M*, *NN*, flat cars, series *S*, *I*, *SS*, etc., are also provided with wooden, mixed and iron underframes. The results of the experience with the frames of the cars in the series *H* and *L* will also apply to these others. In regard to the superstructures of other cars we have given no attention to either flat or covered cars, as the material for the covered cars is all wood, and the side-boards of the flat cars of the Eastern Company are also of wood.

SUMMARY.

The present work presents the real difficulties to be encountered in practice, if the cars are to be so constructed as to give equal durability to all their parts.

The loss from the iron sections entering into the construction of the mixed or iron underframes is not yet very great, even for the oldest cars; but it should receive attention if the cars are to remain in service long enough to double the years they have already served. It should be the practice to cleanse and paint every three years, at least, all surfaces of the iron underframes.

The iron upperframes, without doubt, give a lighter construction to the cars, but they do not add much to the life of cars with wooden or mixed underframes. They constitute the parts most susceptible of criticism in cars of the 1869 type with iron underframes. To-day, after 20 years, upperframes require extensive repairs. It is true that the exigencies of the service of the operating department have become very great, but this is an incentive for strengthening the members of the upperframes. It should be remarked that the cars constructed after the first ten years have these upperframes made of iron or steel sections much stronger than in the earlier cars, and consequently present fewer defects than the older materials.

It is to be hoped that the machine riveting, in cases where it is employed, will prolong the life of the rivets.

For the cars 20 years old and riveted by hand, the rivets present visible traces of fatigue, but it is easy to make their life agree with that of the iron sections they hold together, by observing the precaution, each time the cars go to the shops for heavy repairs, of replacing the worst rivets with new ones. The following proportions will serve as a basis for this substitution:

Fifty per cent. of the rivets holding together the smaller parts of the upperframes.

Twenty-five per cent. of the rivets holding together the gussets which strengthen the corners and of those connecting the floor stringers to the various transverse members.

CONCLUSION.

From all the preceding, it follows that in continuing to apply to the iron freight cars the preservative measures indicated above, which will serve to improve their condition, the Eastern Railroad of France has computed, for the cars of the old types and for the new ones, lives respectively of at least 50 and 60 years.

Air and Gas Compressors as Manufacturered by The Norwalk Iron Works Company.

The present is a time of general interest in the storing and transmission of power, and the two great agents utilized for this purpose, compressed air and electricity, are attracting almost universal attention and study in the engineering and railroad world. The more careful and intelligent study thus directed to compressed air is undoubtedly responsible for much of the phenomenal increase in its use and the variety of the methods found for successfully employing it. As the problems associated with its economical compression, transmission and use are better understood and are satisfactorily solved, new adaptations for it are discovered, old uses are extended and abandoned plans revived and carried to successful conclusions. Furthermore, the great advances in general engineering have brought to the front new and heretofore unheard of conditions in certain industries, to meet which the modern high-grade compressor has been and is being extensively used. If anything more is needed to explain the increasing favor with which compressed air is viewed in the last few years it may be attributed to the perfection to which compressors have been brought by the manufacturers, though it must be stated in this connection that the latter have always led the way and been in advance of the needs of their customers.

Prominent among the builders of compressors in this country is the Norwalk Iron Works Company, of South Norwalk, Conn., who have been identified for more than a quarter of a century with nearly every important step in the improvements by which the inefficient single cylinder "wet" compressor of 30 years ago, built only for low pressures, has been developed into the excellent compound or three stage machine of to-day, adapted for pressures ranging as high as 5,000 pounds per square inch. This company was established in 1868. At that time the building of the Earle water pumps was the chief business of the plant, but a few years after the organization Mr. Ebenzer Hill, the present General Manager, became associated with the company, and he, realizing the importance of the field for compressed air and the great opportunity for improvement in compressors, directed the energies of the concern into these new channels. The success of the enterprise was so great that the construction of water pumps was abandoned long ago and for years compressors for air and gas have been the sole output of the company.

At that time air compression was in its infancy. As far as known there were no compound air compressors in use in this country, and it is said that the only one of that type running in Europe was an experimental one. Even the earliest patterns of the Norwalk company were what was known as "wet compressors" from the fact that water was used in direct contact with the air in the air cylinder to cool it during compression. But when their efforts were concentrated upon the production of compressors that were correct both in theory and in practical results, their designs were characterized by improvements on the current practice of the day, which contributed much to the high reputation they now hold. We have not the space to describe these in detail, but it is interesting to note that the concern was the first in this country to use compound or two-stage air compression and also the first to employ mechanically-actuated valves on the intake cylinders. They were also the leaders in the movement toward higher pressures, the first to make a com-

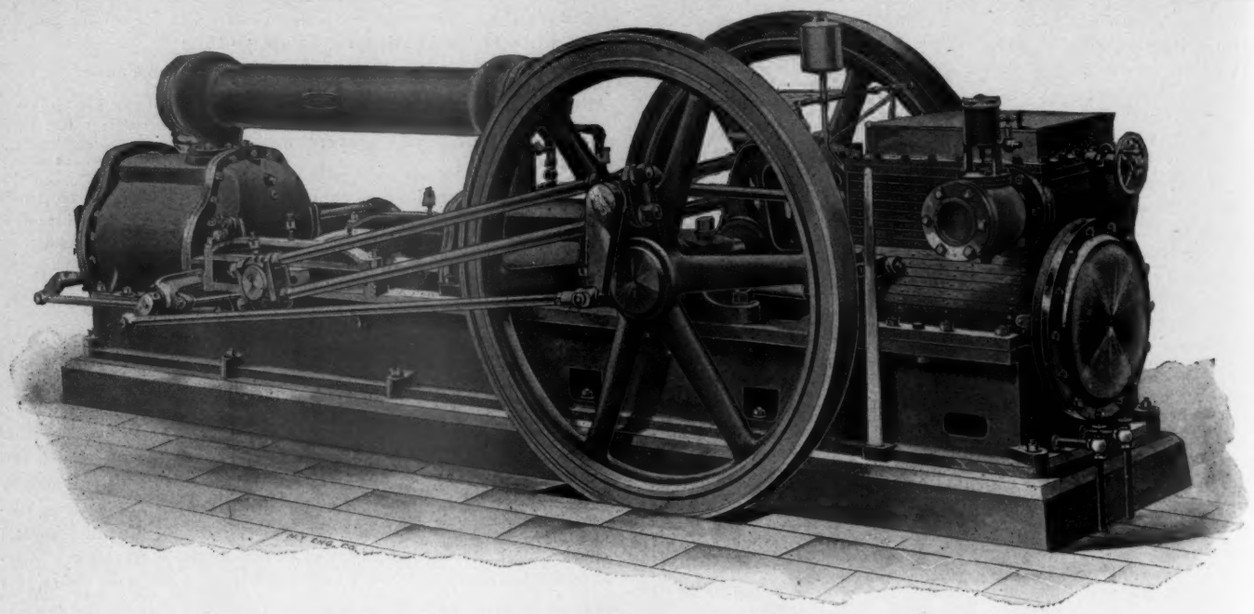


Fig. 1.—Norwalk Standard Steam Actuated Air Compressor.

mercial machine for liquifying carbonic acid gas, and to install a large plant for compressing natural gas. Such an enviable record of progress in the adoption of advanced principles and details of construction has naturally brought to the company much special work, until at the present day it is hard to say whether they are better known through their standard types of compressors or the special ones designed and built by them for unusual lines of work. Among the latter might be mentioned the air compressors for furnishing compressed air to operate the pneumatic dynamite guns of the U. S. Cruiser *Vesuvius*, which were designed to furnish air at 5,000 pounds pressure. They have also supplied the government with the compressors for the new

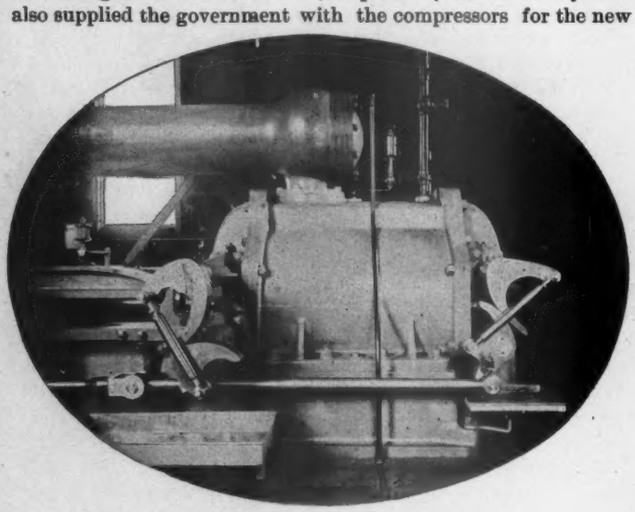


Fig. 2.—Valve Gear on Intake Cylinder.

monitor *Terror* on which air is used for raising ammunition, moving turrets, etc. Other special uses, such as for disappearing gun carriages, compressing hydrogen to 2,000 pounds pressure, the compression of illuminating gas for storage, etc., might be noted, but it will suffice to say that the company has been and is now ready to undertake any special work involving any pressure that can be successfully utilized after leaving the compressor.

While much of this special work carried on by the company would be of great interest to our readers, the limits of our space compels us to be content with a reference chiefly to their standard types. The first of these to which we would call attention is their standard steam actuated compound air compressor shown in Figs. 1 and 2.

In this, as in all other compressors built by the company, the machine is self-contained, all the parts being mounted upon one massive bed-plate, thus avoiding out-board bearings and expensive foundations, and assuring perfect alignment. The air and steam cylinders are in line, the forces being transmitted in a direct line from piston to piston, and the steam cylinder with its high temperatures is as far removed from the intake cylinder as possible. Of course, the steam cylinder and valves can be of any good design, but in all their regular work the company use the Meyer valve gear, with cut-off valves riding on top of the main valve. The mechanism of this gear has recently been greatly simplified, and is now constructed in a manner shown most clearly in Fig. 3, which is a sectional view of a compressor similar to the one in Eigs. 1 and 2, except that the steam end is compounded also. Only one larger rocker is used instead of the two formerly employed and the eccentrics are likewise reduced in number. It will be seen that the eccentric is connected to the one rocker, and through it drives the main valve, while by a large "horn" or extension of the eccentric strap the cut-off valve is driven direct. The cut-off on the high-pressure cylinder can be adjusted while the compressor is runing by means of the hand wheel on the extension of the valve rod.

Before leaving Fig. 3 we would state that in compressors having the steam end compounded, the pistons and cylinder heads are so arranged that both of the former can be removed through the low-pressure cylinder. This cylinder does not have to be removed to get at the interior of the high-pressure cylinder. By an ingenious arrangement one gland and packing makes the piston rod steam-tight between the two cylinders.

Turning from the steam end we find the intake and high-pressure air cylinders are in line, with the crosshead between them. This crosshead is a wide one with pins at its ends for the connecting rods that lead to the cranks on the fly-wheel shaft. The piston rods are not connected directly to the crosshead, but are both keyed to a block held in the crosshead by the vertical pin shown in Fig. 3. This permits the crosshead to swivel slightly and thus adjust itself to the length of the connecting rods without straining the piston rods. There is also a slight vertical adjustment provided by means of this same block to compensate for the wearing down of the crosshead and guides.

In a steam cylinder using steam expansively, the greatest force is exerted during the early part of the stroke, while in an air compressing cylinder the power required is largely in the second half. Instead of providing heavy fly-wheels to absorb and give out power in different parts of the stroke, the inertia of the reciprocating parts is utilized for this purpose. The piston rods

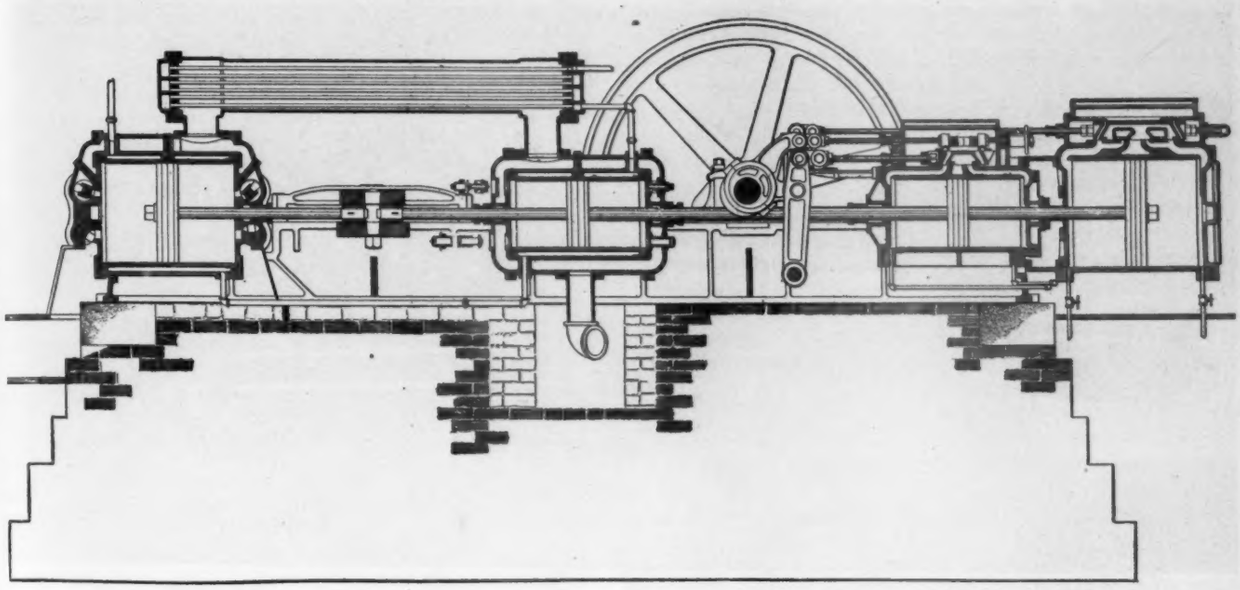


Fig. 3.—Sectional View of Norwalk Compound Air Compressor Driven by a Compound Steam Engine.

and crosshead represent in the aggregate considerable weight, so that it requires most of the power of the steam over and above the air resistance at the beginning of the stroke to start them forward at the required speed. At the end of the stroke, when the steam has become weak by expansion, the power stored up in the momentum of these reciprocating parts is given out in useful work, and the parts are brought to a state of rest by expending their force upon the air in the compressing cylinders. The weight of these parts is purposely made sufficient to give the desired result, consequently the flywheels can be made comparatively light and there are no heavy strains to be transmitted between them and the pistons.

The valves on the inlet cylinder are of the Corliss type, and it will be seen that both inlet and discharge valves are mechanically actuated. The selection of inlet valves of this type was made after a careful investigation of all other forms. Poppet valves are a source of loss from their resistance to opening. It has been found that to make poppet valves operative at all reasonable speeds and conditions, the springs on them must have a force equal to at least eight ounces of air pressure per square inch of valve area. Small as is this pressure, it considerably reduces the amount of air taken in at each stroke, compels the compressor to be run at a higher speed to deliver a given quantity of air, and altogether causes a loss which is not less than 4.8 per cent. and may be more if the conditions are unfavorable. Furthermore, these Corliss valves permit the air to enter the cylinder in large streams and reduce to a minimum the heating of the air from passing over heated metallic surfaces. To further insure the entrance of cool air at the intake cylinder, it is recommended that the air be taken from a cool place outside of the engine-room and led to these valves through wooden conduits, for the attachment of which to the cylinder heads provision has been made. As showing the importance of cool air for compression we present the following table, in which is tabulated the discharge of a com-

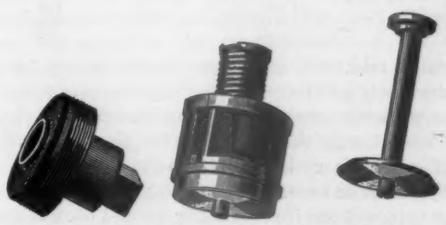


Fig. 4.—Norwalk Poppet Valves.

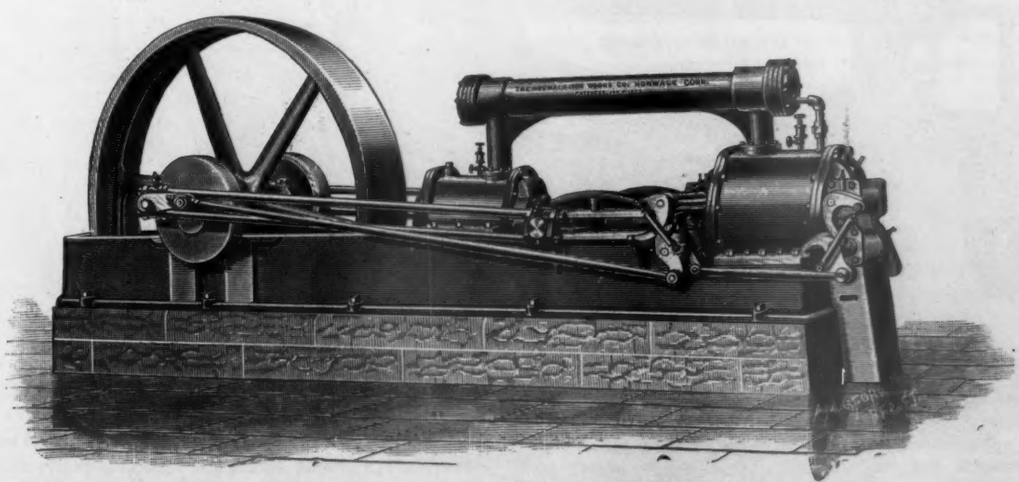


Fig. 5.—Norwalk Belt-Driven Compressor.

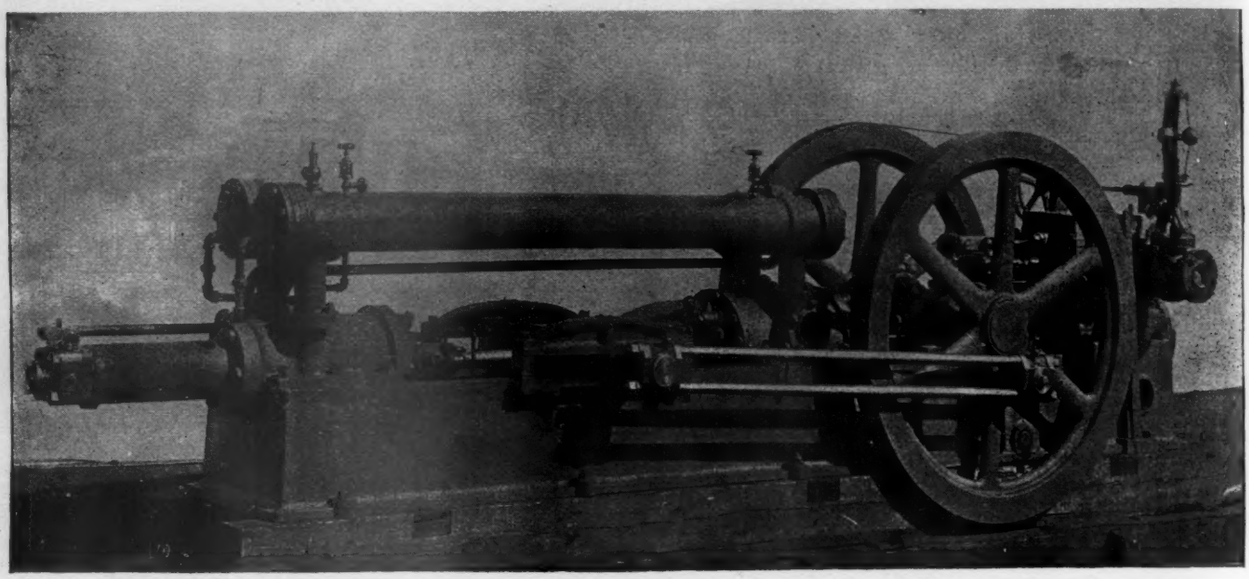


Fig. 6.—Norwalk Compressor for Carbonic Acid Gas.

pressor having an intake capacity of 1,000 cubic feet per minute, for several different temperatures at the intake:

Temperature of intake air.	Volume taken into compressor.	Volume discharged if measured at 62 degrees and atmospheric pressure.
0	1,000 cubic feet.	1,135 cubic feet.
32	1,000 "	1,060 "
62	1,000 "	1,000 "
75	1,000 "	975 "
80	1,000 "	966 "
90	1,000 "	949 "
100	1,000 "	932 "
110	1,000 "	916 "

The above tabulated gains and losses are due to changes in temperature only and have no bearing whatever upon the power needed to work the compressor. The temperature of the intake air does not change the power needed to operate the machine. The resulting efficiency is changed as above shown.

In a compound or two-stage compressor the point at which the discharge valves of the first cylinder should open is fixed by the ratio between the cylinder volumes, and advantage is taken of this fact to give such valves a positive motion. The valve mechanism on this cylinder of the Norwalk air compressor is ingenious. It can be seen best in Fig. 2. The intake valves are driven direct by a connection to a return crank on each end of the fly-wheel shaft, and the discharge valves are opened by means of peculiar shaped cams on the stems of the inlet and discharge valves. These cams allow the discharge valves to stand still during a large part of the stroke and at a time when the pressure in the cylinder is much less than that on the other side of the valve, and then they rapidly open the valves when the air in the cylinder has about reached delivery pressure and the valves are almost in perfect balance. This reduces to a minimum the wear on the valves and valve mechanism and reduces greatly the power required to operate them. The discharge valves are closed by the spring connection between the cams.

The air after passing through the intercooler is admitted into the second cylinder by poppet valves. These and the outlet valves of the same type are placed in an accessible position in the cylinder heads, and are carefully designed. The valve, valve

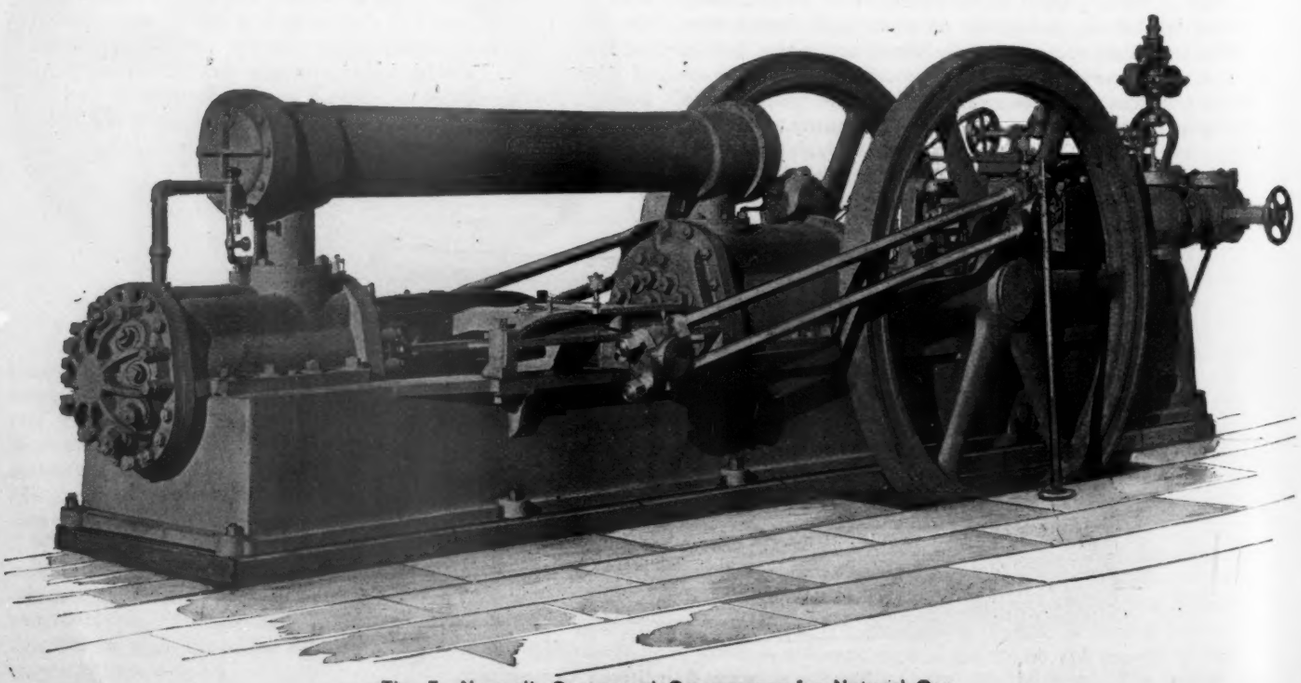


Fig. 7.—Norwalk Compound Compressor for Natural Gas.

stem and head are all forged in one piece, as shown in Fig. 4, so that there are no stems, nuts or split pins to get loose. To permit of this construction, the guide for the stem is made in halves and secured by the seat itself, while the spring is turned into proper position under the head in much the same fashion as a corkscrew is worked, the wire of the spring passing through the small score in the head of the valve seen in the middle view in Fig. 4. The neatness of the arrangement has to be seen to be fully appreciated. This same valve is used in the company's gas machines.

The arrangements for cooling the air are deserving of attention. These consist of jackets on both cylinders and an efficient intercooler. The importance of proper cooling can be better realized when we consider the heat of compression. The extent of this for ordinary pressures can be seen from the following statement of the final temperatures of dry air compressed without any cooling whatever:

		Degrees.	Degrees.
Temperature of air before compression.		60	90
	Pounds.		
Temperature of air compressed to....	15	177	212
" " " "	30	255	294
" " " "	45	317	362
" " " "	60	369	417
" " " "	75	416	465
" " " "	90	455	507
" " " "	105	490	545
" " " "	120	524	580

Perhaps the part this heating plays in work of compression will be better understood from a practical example. Air compressed to 5 atmospheres, or 60 pounds pressure on the ordinary gage, in a compressor without cooling arrangements, would be raised in temperature from 62 degrees to 373 degrees Fahrenheit. Assume that the amount of air is such that it requires an engine of 100 horse-power to do the work. If now a *perfect cooling* apparatus be added to the compressor, the power required would be reduced from 100 down to 78.4 horse-power. In other words the value of a perfect cooling apparatus to that compressor would be 21.6 horse-power. So much cooling cannot be obtained from a single cylinder jacket. In a compound compressor doing the same work the temperature of the air on leaving the first cylinder would be 199 degrees, if the cylinder had no jacket. All this heat above the atmospheric temperature can be taken out in the intercooler. By thus cooling the air the original 100 horse-power required will be reduced to 88.1 horse-power. But we have seen that by perfect cooling another gain of 9.7 horse-power is possible. To effect this a water jacket is put on each of the two air cylinders. In this manner a large part of the gain from cooling is made sure by using an intercooler, and of the remaining gain which is theoretically possible, as much as possible is realized by the use of cylinder jackets.

In the Norwalk compressor the jackets are formed by bushing the cylinders, the main casting being so formed as to leave an annular space around the bushing when the latter is in place. This is a more reliable construction than casting the cylinder all in one piece, as there is no danger from misplaced cores. It also permits the use of a harder and better wearing material in the bushing, and this opportunity is not neglected by the company. The intercooler is the cylindrical chamber mounted on top of the air cylinders and is made of ample volume to give time for complete cooling. The cooling water circulates through numerous pipes to pass which the air must be divided into many small streams.

As already stated, the company are firm advocates of the compound compression, and were the first to employ it in this country. The reasons for their practice have been given in the foregoing, where the gain in efficient cooling was illustrated. Such cooling cannot be effected in a single cylinder by means of one water jacket. Furthermore, there is more uniform resistance throughout the stroke in two-stage than in single cylinder compression. At the same time they build many single compressors for such work as they are adapted to.

We have thus far confined our attention to steam actuated air compressors with either single or compound steam cylinders according to the steam pressure available. The company also build belt driven compressors of the type shown in Fig. 5, in which all the economies at the air cylinders are realized as fully as in the machines already described. For utilizing water power a similar compressor is built in which a Pelton or other water wheel takes the place of the belt wheel shown.

Mention has already been made of the compressors built for compressing and liquifying carbonic acid gas. One of these machines is shown in Fig. 6. The gas first enters the large cylinder through the opening shown, and after compression passes through one of the two intercoolers, thence into the second cylinder, next into the other intercooler, and then into the small cylinder to the extreme left. The first cylinder is double-acting and the others single. The pressure required for liquefaction is of course dependent on the temperature and is in usual practice about 1,200 pounds. The cylinder head on the last cylinder is made of forged steel, and it is found that cast metals are too porous for the pressure. The air cylinders cannot be lubricated with oil because the gas must not be contaminated in the least, and special devices are resorted to for producing frictionless movement.

In Fig. 7 we give a view of one of several compound compressors built for compressing natural gas for the city of Tiffin, O. Each of these compressors is capable of delivering 5,000,000 cubic feet of gas per day through 80,000 feet of 8-inch pipe. These machines differ slightly from the company's regular design of compound compressors in having the large intake cylinder, which is subjected to the lightest pressure, in the middle of the machine. This was done in order that the second or high-pressure cylinder could be thrown out of gear until the changing condition of the field required its use.

One of the largest natural gas pump installations supplied by the company is at Greentown, Ind., where the compressors send the gas to Chicago, 116 miles, through two lines of 8 inch pipe. Last winter the plants equipped with Norwalk compressors averaged a delivery of 100,000,000 cubic feet per day. In some of these natural gas plants the conditions are such that single cylinder compressers are best suited to the requirements and the company has installed a number of these machines at various places.

Several railroads have used ordinary illuminating gas for car lighting and in such cases have needed compressors for that gas. The Pennsylvania Railroad and the Philadelphia & Reading Railroad are using Norwalk compressors for this purpose. The Pennsylvania Railroad has all told 21 Norwalk compressors in service.

There is an attraction about large machinery that captivates many, but this company, though prepared to build compressors of almost any size, do not generally advocate anything larger than 32 inches by 36 inches, believing that in the average large plant it is wiser to adopt approximately that size for each unit and increase the number of units until the desired total capacity is obtained. The workmanship entering into the Norwalk compressors is in keeping with their excellence of design, and whenever the company is acquainted with the exact needs of a customer, a compressor is built which exactly fits those requirements. In conclusion, we would say that those who want to know more about Norwalk compressors or the general principles underlying air and gas compression, should write for one of the company's catalogues. This book is almost a scientific treatise on compressed air, so full is it of valuable information on this subject.

According to the *Railway Age and Northwestern Railroader* the new railroad construction for the first six months of this year is 717 miles, as against 622 miles for the same period in 1895, 495 in 1894, 1,025 in 1893, 1,284 in 1892, 1,704 in 1891, and 2,055 miles in the first half of 1890.

The big steamer building at the Vulcan yard, Stettin, Germany, for the North German Lloyd Company, and which is to compete with the famous Cunarders *Campania* and *Lucania*, will be 625 feet long, 66 feet beam, and 43 feet deep, and her engines will develop 28,000 horse power. A similar ship is also being built at the works of Mr. Scichan at Dantzic. Another of the big German shipping corporations, the Hamburg-American Company, is having built at Harland & Wolff's yard, Belfast, Ireland, a steamer that will be the biggest freight carrier in the world. Her dead weight will be over 12,000 tons and her dimensions are 560 feet long, 62 feet beam and 41 feet deep.

(Established 1832.)

AMERICAN ENGINEER CAR BUILDER AND RAILROAD JOURNAL.

27TH YEAR. 65TH YEAR.

PUBLISHED MONTHLY
BY
R. M. VAN ARSDALE,
MORSE BUILDING.....NEW YORK.

M. N. FORNEY,
W. H. MARSHALL, } Editors.

R. G. CHASE, 705 Western Union Building, Chicago.

AUGUST, 1896.

Subscription.—$2.00 *a year for the United States and Canada; $2.50 a year to Foreign Countries embraced in the Universal Postal Union.*

EDITORIAL ANNOUNCEMENTS.

Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Special Notice.—*As the* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is printed and ready for mailing on the last day of the month, correspondence, advertisements, etc., intended for insertion must be received not later than the 25th day of each month.*

Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

To Subscribers.—*The* AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL *is mailed regularly to every subscriber each month. Any subscriber who fails to receive his paper ought at once to notify the postmaster at the office of delivery, and in case the paper is not then obtained this office should be notified, so that the missing paper may be supplied.* **When a subscriber changes his address** *he ought to notify this office at once, so that the paper may be sent to the proper destination.*

The paper may be obtained and subscriptions for it sent to the following agencies: **Chicago,** *Post Office News Co., 217 Dearborn Street.* **London, Eng.,** *Sampson Low, Marston & Co., Limited St. Dunstan's House, Fetter Lane, E. C.*

CONTENTS.

ILLUSTRATED ARTICLES: Page.

The Altoona Shops of the Pennsylvania Road..... 165
Vauclain Compound Passenger Locomotive for the C., M. & St. P. Ry..... 170
The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes..... 171
Air and Gas Compressors as Manufactured by the Norwalk Iron Works Co..... 177
Speed Control of Modern Steamers..... 187
The Most Advantageous Dimenmensions for Locomotive Exhaust Pipes and Smokestacks.. 190
The Brill Truck for Passenger Cars..... 193
Origin of Pneumatic Tires..... 194
Test of Boilers..... 195
Locomotive Steam Pipes..... 199
Exhibit of Root's Steam Boiler at the National Electrical Exposition..... 200

EDITORIALS:

Altoona Shop Articles..... 182
Pure Feed Water for Boilers.. 182
Heating Buildings by Waste Heat..... 182
Interchange Rules and the St. Louis Tornado..... 182
Oil and Gas Engines..... 182
Steel Underframes for Freight Cars..... 183

MISCELLANEOUS:

Engine Power and Self Propelled Road Traffic..... 170
Engineering Notes..... 184
Personals..... 185
Equipment Notes..... 186
New Publications..... 186
Books Received..... 187
A Water-Power and Compressed-Air Transmission Plant for the North Star Mining Co., Grass Valley, Cal..... 188
Railroad Master Blacksmith's Ass'n..... 194
The Freezing of Gas..... 195
Trade Catalogues..... 196
Master Car Builders' Ass'n Reports..... 198
Master Mechanics' Ass'n Reports..... 199
Manufacturing Notes..... 201
Directory..... 202

The June number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, contained the first of several articles on the Altoona shops of the Pennsylvania Railroad. The convention held in Saratoga in June supplied so much material for the July number of the paper that the second article on Altoona was omitted from that number and now appears in this one. The points of interest which may be observed in Altoona are almost limitless, and the series of articles might be continued indefinitely. The article in this number will be succeeded by several others.

There is hardly such a thing as absolutely pure water obtainable for feeding steam boilers, and as the concensus of opinion seems to be that it is not fit for use in boilers anyway, it is probably fortunate that it is so rare. Apparently pure feed water is found to corrode sheets and flues for some reason not quite clear, and the thinnest of lime scale is found to protect the surfaces from this action. Hence, while very impure waters are to be avoided and the formation of scale reduced to a minimum, feed waters being purified if the conditions are serious enough to warrant the cost of the process, information at present available points to the fact that it is not necessary or even advisable to seek a water absolutely pure or to remove the last grain of lime by a purifying process.

The heating of buildings by means of the waste heat of a steam plant is one of the favorite ways of utilizing heat that would otherwise be a total loss. This is usually done by a use of the exhaust steam from the engine when it is non-condensing, but there was recently published the description of a plant in which the heat is abstracted from the water discharged from the hot well of a condensing engine, and employed to raise the temperature of the air in a hot-blast system, while the air currents generated by the flywheel of the engine are utilized to force the hot air through the ducts. In the case of mills the engines are so large in proportion to the buildings they serve that the heat available is sufficient for the purpose, and in many manufacturing establishments this condition will also obtain. Where such is the case, the system appears to have advantages as the larger heating surface required in the heaters, with its attendant cost and greater space occupied, will be more than offset by the smaller consumption of power.

The tornado at St. Louis has raised an interesting question regarding the limits of responsibility under the Master Car Builders' rules of interchange. These rules say that cars must be returned in as good running order as when received, and the various roads signing the code have agreed to do this. But when property is destroyed by what is in legal phraseology termed an "act of God" the courts will not compel the payment of damages. Some of the roads entering St. Louis were willing to repair at their own cost foreign cars on their tracks damaged by the tornado, while others refused to do so. Some of those refusing did so on the ground that while they might be willing to pay the costs in this case if others signing the code of rules would do likewise in the future, there was no guarantee that such costs could be collected in this or in future cases, nor was there any redress obtainable by taking a future case into the courts. In other words, while the framers of the code of rules might not have so meant it, these rules go further than does the law and involve obligations not recognized in the courts; hence a settlement of this case under the rules would not be fair to the parties interested unless they were assured that in the future the rules would not be repudiated and the protection of the courts sought by those on whom the obligations would fall. There was to be a meeting held in July of those interested at St. Louis to decide upon the course to be pursued, but at this writing we have not learned the results of the conference.

That oil and gas engines are certain to claim part of the field now occupied by the steam engine is susceptible of new proof almost daily. The advantage of economy in small powers, or, in fact, in all powers in which they are as yet built, is with the gas and oil engines, and in many applications the less bulky fuel, the absence of ash, the greater quickness with which the gas engine

can be started, the fact that there is no boiler requiring attendance either while the engine is running or after it is shut down, are all in their favor. One of the latest and most novel applications of the oil engine is on one of the lightships of the United States Government. Here it is made to run an air compressor to supply air for the large whistle used as an audible signal in foggy weather, and one of its great merits in this case is in the fact that it can be started at once when a fog approaches, while with the steam engine there was a boiler to be fired up before power was available. Railroads are also finding a use for these engines at isolated water stations, where a great saving in attendance is found. In fact, wherever the service is intermittent in character the gas and oil engines are doubly advantageous. In many cases, however, where a regular service is desired, the gas engine holds its own and asks no favors of the steam-engine. Unfortunately gas engines have in the past been expensive in the matter of first cost, even costing as much as a steam-engine and boiler of the same power, but the cost is coming down and with the increased demand for them there are opportunities to still further reduce their cost. When this has been accomplished to a sufficient extent the steam-engine will be supplanted to a greater degree than at present.

STEEL UNDERFRAMES FOR FREIGHT CARS.

If we read the signs of the times rightly, the substitution of steel for wood in the construction of freight cars, particularly in their underframes, will make material progress in the near future. The reduced cost of steel and the increasing capacity of cars are both favorable to the change, and steel is being considered by enterprising railroad officials; there is at present a better prospect for a thorough trial of the metal construction than at any time in the past. It is hardly to be expected, however, that great numbers of steel cars will be built immediately, or that the experiences of the near future will be limited to a few designs only. The practical experience of the past has not been such as to converge opinion in favor of any one type; on the contrary, it has left the field open to the invasion of any meritorious design. This condition of affairs is most favorable to those who have special or patented constructions to present to railroad officials, but it is puzzling to the latter, as it is difficult to select from those available a design that shall be put to the test of regular service, without some practical data as a guide in making the selection—data which is not at hand and cannot be obtained by a brief test of a sample car. Designs must be chosen, therefore, by the best judgment that can be exercised without the aid of such data.

Among those who have carefully considered the problems of steel-car construction the question which presents itself for solution is not how the car shall be made to carry a certain load, but rather what are the essential features of a design that shall embody the minimum of weight with the maximum of durability under the action of corrosion, the shocks and complex strains of service and the occasional damage from wrecks, and which shall at the same time be easy to repair when repairs are needed? In other words, the building of steel cars, or cars with steel underframes, is a matter of cost—not the first cost only, but the total cost during the life of the cars. Hence those who contemplate giving them a trial, while not unmindful of the first cost, are naturally desirous that the design selected by them shall ultimately yield the most satisfactory answers to such questions as How long will the cars last? What will it cost to maintain them? How will they go through wrecks? Will bolts and rivets get loose and cause trouble and expense? How can corrosion best be prevented and its effects minimized? While the answers to these questions cannot be drawn from present experience in this country we think there is every reason to believe that when the answers are forthcoming they will be decidedly favorable to the cars with well-designed steel underframes.

As we have not any extensive experience in America on which to draw at this time, our readers will doubtless be interested in an article on another page of this issue, in which is related an experience of 35 years with iron and steel in car construction on the Eastern Railway of France. The freight cars in use on that road are small in comparison with American cars; they are carried on four wheels and are undoubtedly subjected to less rough usage than our cars, and yet there is much valuable experience there related, which will be a help to officials here in deciding upon designs for their cars. Briefly stated, the experience of the Eastern Railway is that while wooden underframes have a life of from 25 to 30 years, the metal underframes of similar cars, after 20 years of service, are in such excellent condition that their total life is estimated at from 50 to 60 years; that the upperframes, when made of iron, being of much smaller sectional areas, will corrode more rapidly and will not last more than 30 years; that the riveting, if of good design and workmanship, will not become loose from shock or vibration, and that serious corrosion in the rivet holes can be prevented by making the rivets completely fill the holes, machine riveting being preferred to hand riveting for this reason; and that the evils of corrosion can be greatly reduced by painting the metal work at least once in three years.

As we have already intimated, the experience of railways in France may not be in all respects directly applicable to conditions in this country, but a number of conclusions valuable for general guidance would appear to be warranted, the first of which is that properly designed steel underframes will last at least twice as long as underframes of wood. Wooden frames in France have apparently a longer life than in this country. Here many place the average life of a freight car at not more than 15 years, but there is good reason to believe that the true figure is nearer 20 years, while French cars of the type investigated last 30 years. As the French underframes of iron have double the life of the wooden ones, and as there do not appear to be any service conditions here particularly prejudicial to metal frames, it is reasonable to expect that the use of steel will double the life of the underframes of American cars. In fact, there is good cause for believing that in this country the life will be more than doubled. In the first place, our cars carry from three to six times as much load as French cars. This means heavier cars with larger steel sections in their frames. These larger sections will suffer from less corrosion, admit of more substantial construction at the riveted joints, and in every way tend to increased life. The only offset to this is the rougher handling of the cars in this country, and even in this respect the difference is more apparent than real, for the heavier and stronger frames required for the heavier loads are better adapted to resist the effects of rough handling. All things considered, therefore, it seems justifiable to conclude that the average life of steel underframes in this country will be at least double that of wood, or, in other words, will exceed 40 years, and that if proper precautions against corrosion are taken this period may be greatly increased.

The second lesson that can be drawn from the condition of the French cars is that, other things being equal, a frame composed of few pieces, and these of relatively large sections, will last longer than a frame having a larger number of smaller parts. The former is also commendable for its simplicity, the reduction of riveted work, and the accessibility of its parts. Such a frame will not only resist the action of the elements better, but it should prove lighter on repairs, less liable to damage in a wreck, and more easily put in shape when damaged.

Another point that should not be lost sight of is the fact that good riveting will not give any trouble in service. It will not loosen from shock or vibration, nor will it corrode if the rivets fill the holes completely. The importance of the rivets filling the holes was brought out by several who took part in the discussion on steel underframes at the M. C. B. convention in June, and need not be enlarged upon here. It is well to point out, however, that the experience of the French does not lead them to consider for a moment the use of bolts instead of rivets.

If we could have given space to all of the engravings which appeared in the original of the article we have translated, the influence of paint as a preservative against rust would be more striking. In the underframes, the corrosion is greatest on such surfaces as are covered by other parts, more particularly those covered by the flooring. Next in order are inner surfaces, not

covered, but difficult to reach with a paint brush; and finally there are the exterior surfaces, easily accessible, and almost free from corrosion. It would appear to be a wise precaution to so make steel underframes that when the flooring is being renewed the entire frame could be laid bare, cleaned and painted.

There is not much encouragement for metal upperframes in the article we are discussing. Because of the small sectional area of the various parts, corrosion is an important factor, and they have no longer life than the wooden frames. In this country, the greater size of the cars would permit of heavier sections being employed in the upperframes, from which a greater life might reasonably be expected. But there is little inclination to use metal upperframes in the United States at present, attention being devoted chiefly, and, we think, wisely, to the underframes. As regards the latter, the experience in France, Germany, India or other countries where they are used is unreservedly in their favor.

It is to be noticed that not a word is said regarding the difficulties of conducting repairs in metal instead of wood. And yet French railway officials had to meet the same conditions as our master car builders must face in introducing the steel frames Twenty-five years ago they were using wood exclusively, and now they are using iron almost altogether; they had to accept new conditions and methods for making repairs, and as there is not a word about trouble during the transition, we can only conclude that the difficulties experienced were not as great as some officials in this country expect them to be here.

Another strong testimonial in favor of the steel underframes and the low cost of repairs comes from the few roads in this country that have had any experience with well-designed frames in regular service. The Norfolk & Southern road, for instance, finds that the cost of repairs for the four years it has used steel underframes is practically nothing. It certainly appears that repairs to steel cars will come so slowly and be so small that the problem of making such repairs cheaply can be solved leisurely.

Whether it is better to begin with mixed underframes and afterward take up frames entirely of steel admits of two opinions, but we firmly believe that the better way is to go to all-steel underframes without any intermediate steps. As to the question of special and patented sections versus regular structural shapes, a decision will be reached only after experience with both. Some of the cars constructed from special shapes already brought to the attention of railway officials are admirably designed, but before they will be adopted to any large extent they will undoubtedly be called upon to compete with cars constructed of regular structural shapes. It will then be a survival of the fittest. It would appear that in the designing of steel underframes there is a chance for the mechanical department and the chief or bridge engineer to work together. The latter ought to be able to render valuable assistance.

NOTES.

For five summers the Baltimore & Ohio has been compelled to haul water in tanks from the Ohio River to supply its locomotives in West Virginia, where the mountain streams give out in dry weather. To avoid this a reservoir with a capacity of 3,000,000 gallons is building at Glover's Gap, W. Va. The water will be furnished by artesian wells, several of which have been drilled in the vicinity. On the Pittsburgh Division, near Triadelphia, a similar but smaller reservoir is being built for the same purpose.

The Royal Agricultural Society will hold its 1897 meeting at Manchester, England, when prizes of $500 and $250 are offered for the best self-moving vehicle for light loads, and similar sums for the best heavy self-moving vehicle. Those of the former class are to be designed for loads up to 2 tons, and the latter for loads of 5 tons, the weight of the vehicle itself being excluded. Where petroleum is used, the specific gravity of the oil must not be less than .8, and the flashing point not less than 73 degrees Fahr. The trials will consist of a run of 50 miles and return, and careful measurements of fuel and water consumed will be made. The maximum speed is placed at 10 miles per hour. Entries must be received before April 1 next, and may be sent to Mr. Ernest Clarke, 13 Hanover Square, London, W., from whom further information can be obtained.

The United States Lightship Board recently installed a unique signaling plant on Lightship No. 42, stationed off Cape Cod. The boat's visual signals consist of fixed white lights in gratings at the two mastheads, and its audible signal is an immense whistle operated by compressed air. Power for compressing the air is furnished by two Hornsby-Akroyd oil engines of 25 horse power each. These engines can be started up in from 10 to 15 minutes, and as compressed air is always kept stored in reservoirs of sufficient capacity to run the whistle for 20 minutes, the whistle is ready for service at a moment's notice in case of sudden fog. Theair is compressed to 60 pounds pressure and passes through a reheater and a reducing valve before going to the whistle. The reheating is done on the score of economy and also to prevent the whistle from clogging with the frost and ice that would otherwise be formed by the cooling effect of the expanding air.

The *Monthly Bulletin* of the Bureau of American Republics for June has an article on the railway systems of the Argentine Republic in which the total railway mileage is given at 14,029 kilometers (about 8,760 miles); of this total five lines are the property of the nation with a length amounting to 1,026 klilometers; 10 lines with a total length of 3,834 kilometers are guaranteed by the Government; seven lines of 6,241 kilometers are without national guarantee, and seven lines, comprising 2,928 kilometers are subject to provincial jurisdiction. In 1894 there were in service 1,112 locomotives, of which 868 were of English manufacture, 144 American, 68 French, 12 Belgian, 9 Canadian, 2 German and 4 of home manufacture. There were 1,456 passenger coaches, of which 824 were of English manufacture, 235 American, 184 Argentine, 92 French and 121 the manufacture of which is not given. There were 31,039 freight cars, 17,940 of which were of English make, 6,421 Argentine, 1,496 American, 1,265 French and 3,917 not stated.

The United States navy is not the only one in which there is dissatisfaction because of improper treatment of the engineer officers. In the British navy the same trouble exists and in the hope of educating public opinion to an appreciation of the injustice systematically dealt out to the engineering staff, *The Practical Engineer* began in its issue of May 15 a serial story entitled "The Naval Engineer and the Command of the Seas." In the course of the story war is declared between England and France and the first naval engagement takes place in the Mediterranean, and is described in an interesting manner. The battle might have terminated in favor of the English had not a second French fleet appeared upon the scene, compelling the English to beat a retreat. The importance of the work of the engineering staff is brought out in connection with the maneuvers of the vessels, and the appearance of the second French fleet is attributed to the impossibility of getting engineers and artificers to man a sufficient number of British men-of-war to keep the Frenchmen in port. As a story it is thus far quite interesting, and it is to be hoped it will serve a useful purpose.

One of the new fast passenger engines on the Chicago, Rock Island & Pacific Railway made an excellent run from Chicago to Rock Island on June 3. The run of 181.3 miles was made in 3 hours and 28 minutes, the train making seven stops and seven times slowing down to 25 miles per hour in passing over interlocking plants and bridges. Furthermore, 31 minutes was consumed in going the first 15 miles, because of the difficulty of getting out of the city over the tracks which are being elevated. That leaves only 2 hours and 57 minutes for the remaining 166.3 miles, making the average speed for that part of the run 56.37 miles per hour, including the seven stops and seven slow-downs. The train consisted of five cars, weighing 452,170 pounds, or over 226 tons. The new engines are known as "Class 22 A," and are of the eight-wheeled type. They have cylinders, 19½ by 26 inches; driving-wheels, 78 inches in diameter; radial-stay wagon-top boilers, 61 inches in diameter at the smallest course; total heating sur-

face, 1,988.3 square feet; grate area, 2.45 square feet; boiler pressure, 190 pounds; driving wheel base, 8 feet 6 inches; total wheel base of engine, 28 feet 1½ inches; weight on drivers, 83,000 pounds; weight on truck, 42,000 pounds; total weight of engine in working order, 125,000 pounds. The engines have large bearings and wearing surfaces. The boiler is of carbon steel, the driving-wheels of cast steel, the axles of Cambria steel, treated by Coffin process, Krupp steel tires, Nathan sight feed lubricators, Ashton safety values and mufflers, Jerome metallic packing. French springs, Star steam gages, American driver brakes, Sargent driver brake shoes, Monitor injectors, Barabor bell-ringers, Mason reducing valves, Marden brakebeams and Westinghouse brakes on tenders.

Personals.

Mr. L. A. Riley has been elected President of the Lehigh & Lackawanna Railroad.

Mr. Leon Hart has resigned as Receiver of the Texas, Sabine Valley & Northwestern.

Mr. K. H. Bates has been elected President of the Kansas City, Oklahoma & Southwestern.

Mr. J. T. Atwood has been appointed Chief Engineer of the Pittsburgh & Lake Erie Railroad.

Mr. Hugh J. Fitch has been appointed Receiver of the St. Louis Avoyelles & Southwestern Railway.

C. C. Crooke, President of the Altamont & Manchester Railroad, died at Stanford, Ky., on July 9.

Mr. S. T. Prince, of Mobile, has been appointed Receiver for the Seaboard Railway Company of Alabama.

Mr. Sidney Emerson has been appointed Chief Engineer of the Wabash, with headquarters at St. Louis, Mo.

Mr. T. H. Perry has been made Purchasing Agent of the Cleveland, Akron & Columbus, with office at Indianapolis.

Mr. B. E. Taylor is appointed Purchasing Agent of the Louisville, New Albany & Chicago, vice J. H. Craig, resigned.

Mr. William J. Dale, Jr., has been reappointed a State Railroad Commissioner of Massachusetts for three years from July 1.

Mr. Chas. H. Grundy has been appointed General Manager of the Marshfield & Southeastern, with office at Marshfield, Wis.

Mr. W. H. Smith is appointed Purchasing Agent for the Atlantic & Pacific Railroad, with headquarters at Albuquerque, N. Mex.

Mr. George W. Kenny is appointed Superintendent of Motive Power of the Rutland Railroad, with headquarters at Rutland, Vt.

Mr. A. McLean has been appointed Superintendent of Motive Power and Equipment of the Georgia Northern, with headquarters at Pidcock, Ga.

Mr. Joel H. De Victor has been chosen Vice-President of the Eagles Mere Railroad, with headquarters at Philadelphia, Pa., vice Mr. John R. T. Ryan.

Mr. Joseph McWilliams has resigned as General Superintendent of the Texas Central to accept the position of General Manager of the Marietta & North Georgia.

Mr. William Youngquist, for more than 25 years Foreman of the Chicago, Burlington & Quincy Car Department, died at Creston, Ia., on June 22, aged 54 years.

Mr. W. J. Lewis has been appointed Purchasing Agent of the Peoria, Decatur & Evansville Railway, with headquarters at Evansville, vice H. W. Matters, resigned.

Mr. S. B. Fisher, formerly Assistant Chief Engineer, has been promoted to the position of Chief Engineer of the Missouri, Kansas & Texas, with office at St. Louis, Mo.

Mr. John H. Winder, President of the Seaboard Air Line Belt Railroad at Atlanta, Ga., has resigned, and Mr. R. C. Hoffman, of Baltimore, has been chosen to succeed him.

Receiver and General Manager C. W. Smith, of the Atlantic & Pacific, has removed his headquarters from Albuquerque, N. Mex., to the Great Northern building, Chicago.

General Manager J. H. Macleary, of the Suffolk and Carolina Railway, has resigned and General Superintendent Geo. L. Barton will for the present perform the duties of the office.

Mr. W. F. R. Mills has been appointed General Superintendent and Purchasing Agent of the Denver, Lakewood & Golden, vice J. B. McCormic, previously General Superintendent.

Mr. O. O. Winter, Superintendent of the Willmar Division of the Great Northern, has resigned to become General Manager of the Brainerd & Northern road, a lumber line in Minnesota.

Superintendent Conklin, of the Buffalo, Attica & Arcade, has resigned. Samuel T. Dyke is acting as Master Mechanic, and has entire charge of the roadbed, construction and rolling stock.

Mr. Sanford Keeler, recently General Manager of the Saginaw, Tuscola & Huron road, in Michigan, has been appointed General Manager of the Interurban Electric Railroad, at Saginaw, Mich.

On July 1 Mr. J. Gibbons retired as Chief Engineer of the Vandalia, and his duties devolved upon Mr. F. T. Hatch, in connection with his duties as Superintendent of the Michigan Division.

Mr. Henry G. Morse has accepted the presidency of the Harlan & Hollingsworth Company, ship and car builders, succeeding Mr. W. Taylor Gause, resigned. Mr. Morse was fornerly President of the Edge Moor Bridge Works.

Mr. Joseph H. Green, Master Mechanic of the Southern Railway of Columbia, S. C., has resigned to accept the position of Superintendent of Motive Power and machinery of the South Carolina & Georgia Railroad, with headquarters at Charleston, S. C.

Mr. William Berdan, Secretary and Treasurer of the Cooke Locomotive and Machine Company, of Paterson, N. J., has resigned to become Secretary of the National Association of Locomotive Builders, with offices at 26 Cortlandt street, New York City.

Mr. Horace G. Burt, General Manager of the Fremont, Elkhorn & Missouri Valley, will succeed Mr. E. W. Winter as General Manager of the Chicago, St. Paul, Minneapolis & Omaha. Mr. Burt was formerly Chief Engineer of the Chicago & Northwestern Railway.

Mr. George F. Bidwell, Superintendent of the Ashland Division of the Chicago & Northwestern, has been made General Manager of the Fremont, Elkhorn & Missouri Valley lines, to succeed Mr. Horace G. Burt, who becomes General Manager of the Chicago, St. Paul, Minneapolis & Omaha line.

Mr. John C. Sanborn, Superintendent of the Plymouth Division of the Old Colony road, has been elected General Manager of the Boston Terminal Company, which is to build the new Southern Union Station in Boston. He will make a trip abroad to inspect European railroad passenger stations.

Mr. A. G. Wright has been appointed Division Master Mechanic of the Chicago, St. Paul, Minneapolis & Omaha Railroad, with headquarters at Altoona, Wis. He succeeds Mr. W. E. Amann, who resigned to accept the position of mechanical expert for the Galena Oil Company, on the Southern Pacific system.

Mr. B. F. Yoakum, Third Vice-President and General Manager Gulf Colorado & Santa Fe, has been appointed Vice-President and General Manager of the reorganized St. Louis & San Francisco Railroad. Mr. Yoakum has been with the former road for three years, and was previously for several years General Manager and for some time Receiver of the San Antonio & Aransas Pass Railway.

Mr. Nicholas Monsarrat has resigned as President and General Manager of the Columbus, Sandusky & Hocking. He was appointed Receiver of the road in July, 1895, and when the company was reorganized last November he was chosen President and General Manager. He was formerly President and General Manager of the Cleveland, Akron & Columbus.

Mr. A. L. Studer is appointed Master Mechanic of the Southwest Division of the Chicago, Rock Island & Pacific, in charge of the locomotive and car department, with headquarters at Trenton, Mo., vice Mr. Wm. Gessler, resigned. Mr. J. B. Kilpatrick is appointed Master Mechanic of the West Iowa Division in addition to his other duties as Master Mechanic of the K. & D. M. and D. M. & Ft. D. Division, with headquarters at Valley Junction, Ia.

Mr. H. L. Morrill, who retires from the positions of Vice-President and General Manager of the St. Louis & San Francisco road, was Manager of Construction in the building of the Nickel Plate line, and was also at one time General Manager of the Hoosac Tunnel road. He entered the service of the St. Louis & San Francisco Company June 1, 1886, as General Manager, and in 1887 was also made Vice-President, and has been with the company ever since.

Equipment Notes.

The Baltimore & Ohio will soon order a number of combination cars.

The Delaware, Lackawanna & Western is in the market for 1,200 cars.

The Bangor & Aroostook Railroad is in the market for between 600 and 1,000 freight cars.

The Carlisle Manufacturing Company has secured an order for 250 cars for the Pennsylvania.

The Boston & Albany is reported as being in the market for quite a number of passenger cars.

The Chicago Great Western has ordered a new Pullman dining-car for use on its Chicago division.

The Pennsylvania will build eight engines at its own shops for the Western Pennsylvania Division.

The Philadelphia & Reading road has let a contract for 500 freight cars to the Depew Car Works.

The Southern Car Line, with headquarters at Atlanta, Ga., will shortly build about 2,200 freight cars.

The Cincinnati, Jackson & Mackinaw received last month five new day coaches and three baggage cars.

Specifications are out and bids are asked for by the Swift Company for 100 or more refrigerator cars.

Orders for the construction of five "Class R" locomotives have been received in the Erie shops at Susquehanna, Pa.

The Shippers' Refrigerator Car Company, 105 Royal Insurance Building, Chicago, are asking bids upon 10 refrigerator cars.

The Indiana Tank and Refining Company, Rookery, Chicago, has recently organized to transport oil, is in the market for 50 tank cars.

The Erie order for 20 engines was divided equally between the Cooke Locomotive & Machine Company and the Rogers Locomotive Works.

The rumor that the Grand Trunk was in the market for about 4,000 cars is denied, but later reports are to the effect that cars will be ordered in the fall.

The Georgia & Alabama has contracted with the Richmond Locomotive Works for six new locomotives, four for freight and two for passenger service.

It is reported that Nelson Morris & Company will soon increase the number of refrigerator cars ordered from the United States Car Company. The present order is for 55 cars.

The Alabama Great Southern Railroad has placed an order for four locomotives with the Richmond Locomotive Works, three being 10-wheel passenger engines and one for switching service.

The Rome, Watertown & Ogdensburg has placed in service a number of new day coaches, each seating 64 passengers. They have Hale & Kilburn seats, and are mounted on Krupp steel wheels.

The St. Charles Car Works have completed three 60-foot postal cars for the St. Louis & Iron Mountain, embodying several improvements suggested by E. J. Peck, General Superintendent of that road.

The Michigan Central Railroad Company is said to have set aside $200,000, which will be expended in new equipment this fall. This road expects to order 12 or more locomotives and about 900 freight cars.

The Butler & Pittsburgh Railroad will soon, according to a Pittsburgh daily, be in the market for a large number of ore cars and locomotives, the intention being, it is said, to spend about $4,000,000 on equipment.

The Illinois Central has 800 cars under contract for delivery in July and August. These orders include 300 refrigerators and 500 coal cars. The road is reported to be in the market for 1,800 cars, but the officers have denied the truth of the report.

New Publications.

THE OFFICIAL RAILWAY LIST, 1896. FIFTEENTH ANNUAL EDITION. *A Complete Directory of Railway Officers etc., and Handbook of Useful Information for Railway Men.* Published by the Railway List Company, Chicago. 403 pages. 4½ by 8¼ inches.

This yearly visitor comes to us with its usual smiling exterior and roseate with red edges. It is filled from title page to "finis" with names of railroads, people, addresses and—advertisements. It is not easy to test the accuracy of the information which it publishes. One of our contemporaries has pointed out some errors which it contains, which leads to the observation that an annual list of this kind of necessity cannot be as accurate and as fully up-to-date as one which is published monthly, like that given in each number of the AMERICAN ENGINEER, CAR BUILDER AND RAILWAY JOURNAL, and which can be corrected 12 times in a year instead of only once. The official list is of a convenient size and form, and is fat with advertising, which denotes prosperity and peace of mind to its properietors, and the esteem in which the publication is held by its patrons.

THE RAILWAY AGE AND NORTHWESTERN RAILROADER, Chicago.

With its issue of July 3d this well-known journal, following the example set by the AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, reduced the size of its pages to 9 inches by 12 inches, and, as a result, it now comes before its readers in an exceedingly neat dress. Its management is to be congratulated for its enterprise in adopting the new form, and the readers of the paper will undoubtedly appreciate the change.

THE ENGINEERING INDEX, VOL. II., 1892-1895. Edited by J. B. Johnson, C. E. Published by the *Engineering Magazine*, New York. 474 pages. 6½ by 9½ inches. Price $4.

The material composing this volume has appeared in the monthly numbers of the *Journal of the Association of Engineering Soc eties* during the past four years. The first volume was published by the managers of the *Journal* and covered seven years immediately preceding 1892. The present volume is published by and at the expense of the *Engineering Magazine*. This enterprising publication has for some time past been conducting an excellent index to engineering literature and it so completely covered the field that the management of the *Journal* has discontinued its index. To those of our readers who are familiar with the index as it has appeared in our contemporary from month to month, no words of commendation are necessary. To others we would say that we believe it is compiled on the only satisfactory basis for such a work, in that it indexes only such articles as appear to have a permanent value and in a few words outlines the contents of each, so that the reader can judge

for himself whether an article is of the character he is seeking. An index which omits to give any indication of the scope or value of its articles falls short of what is required, and one in which nearly everything is indexed becomes too voluminous. But when a selection is made from the great mass of current literature it must be done wisely, and the fact that in this case the selection has been performed by technical experts is a guarantee that is well done. Hereafter, the volumes of the Engineering Index will appear annually, and we are sure they will be welcomed by all who realize that between the covers of these books, if anywhere, there is to be found a complete index of all important articles on any engineering subject they may desire to investigate. We may, each for himself, save clippings or index articles bearing on our own special lines of work, but we don't cover the whole field, and when one seeks information outside of his specialties, he is very much at sea without such an index.

"NEW YORK AS A SUMMER RESORT;" No. 19 of the "Four Track Series."

This is the title of a neat and attractive little book just issued by the Passenger Department of the New York Central road. It has nearly 100 pages, and is 4 inches by 8 inches in size. It contains much valuable information about the city's hotels, restaurants, theaters, museums, parks, excursion resorts, roof gardens, bathing beaches, fishing grounds, bicycle roads, etc. Its pages are illustrated with many fine engravings, and nothing of interest about the city has been omitted. A brief study of the book is sufficient to convince one that there is much in New York to entertain and interest the summer visitor. A copy of "New York as a Summer Resort" will be sent free, postpaid, to any address on receipt of two 2-cent stamps by George H. Daniels, General Passenger Agent, Grand Central Station, New York.

Books Received.

NINTH ANNUAL REPORT OF THE INTERSTATE COMMERCE COMMISSION, 1895. The Government Printing Office, Washington, D. C. 301 pages, 6 inches by 9 inches.

ANNUAL REPORT OF THE MASSACHUSETTS STATE BOARD OF ARBITRATION AND CONCILIATION FOR 1895. 187 pages, 6 inches by 9 inches.

TWENTY-SEVENTH ANNUAL REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF MASSACHUSETTS, including railroad returns for the year 1895. 1082 pages, 6 inches by 9 inches.

ANNUAL REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY, 1895. Governmenr Printing Office, Washington. Seven volumes.

Speed Control of Modern Steamers.

Under the above title Lieut. M. L. Wood, U. S. N., has presented to the United States Naval Institute an interesting paper, suggesting a practical method of directly controlling the engines of steamers from the bridge. After reviewing the practice and improvements in engine-room signals, he proceeds to describe the proposed methods, from which we take the following:

The question naturally comes up, Why is it not practicable to connect the engine telegraph, or a modified form of it, suitable to the new conditions, directly to the mechanism controlling the direction of motion with the speed of the engine, so as to work the engines directly from the pilot-house instead of from the engine-room platform?

It is the object of this paper to show that such a connection is practicable, that it can be made reliable and that it is advisable, on the score of efficiency, by eliminating chances of error in transmitted signals, with increased rapidity in working engines, while preventing damage to engines and lessening the chance of accidents, by allowing constant general inspection while under way by those now stationed to work engines by hand in obedience to signals.

The following is the plan proposed for adoption without interfering with working the engines exactly as at present, when so desired. When the principle is once adopted simplifications can easily be arranged, lessening the number of parts to suit the size of vessel and the different types of engines.

1st. Connect the engine-room telegraph, modified to suit the work, or a special connection designed for the purpose, to a small pinion or suitable gearing, which will move the valve of a small commercial steam steering engine the full extent of its throw, by the movement of the lever in the pilot-house, the motion being so adjusted that the "stop" position of the lever agrees with the position of the valve for "helm amidships." For convenience, call this small steam steering engine the "regulator engine." The pattern is immaterial, only the valve must be specially designed to move with as slight friction as possible, owing to the small travel of the lever.

2d. In place of the drum on the regular engine, fit a shaft, which, by worm and gear or rack and pinion movement, will move a frame sliding in horizontal guides, exactly as the tiller end is moved by a steam steering engine—the middle part of the travel of the frame corresponding with the "stop" position of the lever in the pilot-house and with the "amidships" position of the valve of the steam steering engine used for the regulator engine.

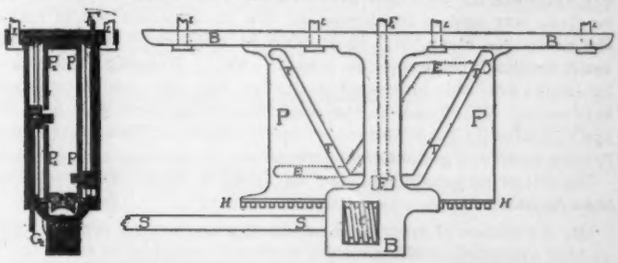
3d. To the frame, called for convenience the "regulator," attach two vertical stiff plates. One of these plates has guide pieces riveted on, or a slot cut, in which a cam, moving in vertical guides, slides. This cam is connected with the valve of the ordinary reversing engine governing its motion. The other plate is connected in precisely the same manner with the main throttle valve. The motion of both cams is controlled by the shape of the slots in which they work, thus regulating the position of the valve of the reversing engine and also the position of the throttle. For every position of the "regulator" there is but one position of the throttle valve and one position of the reversing engine; also these positions will be exactly those required for the most efficient working of the particular engine.

During the middle third of the travel of the "regulator," the direction of motion of the engine is controlled; the outer parts of the travel regulate the speed from "slow" to "full speed" with any degree of nicety required.

4th. Arrange simple accessible means for throwing the automatic engine control apparatus out of action on the shortest notice, allowing the engine to be worked by hand as at present.

There is one mechanical difficulty that interferes with this plan at present. The plan proposed for using these engines as regulator engines will require an easier movement of the valve than is usual with commercial steam steering engine valves. Manufacturers will be able to produce easy moving valves when once in demand; the more readily that as the regulator engine in this plan has to move only two light valves instead of a heavy rudder subjected to violent jerks, a very small, lightly made steam steering engine will handle the engines of the largest battleship.

Let it be assumed that the motion of the pilot-house lever of the ordinary form of engine telegraph through an arc of 90 degress will give a motion of six inches, the whole travel, to the valve of a small "regulator" engine in the engine-room. Then it necessarily follows that the sliding frame or regulator can be made to follow the motions of this valve exactly, by means that are thoroughly tested and reliable. Suppose the drum of the steam steering engine be attached to the shaft shown in *S S*, Fig. 1, which, by means of the worm wheel, *O*, and the cogs, *H H*, gives a rectilinear motion of say 3 feet to the plates, *P P* and P_2 P_2, sliding in bracket, *B B*, Figs. 1 and 2. The movements of the rod, F_2, connecting with the throttle, are governed by the guiding slot, *T T*, and cam, *F*, Figs. 1 and 2. The movements of the rod, G_2, connecting with the valve of the reversing engine, or, preferably, directly to the links of the main engine, are governed by the guiding slot, *E E*, and the cam, *G*, Figs. 1 and 2, in the plate P_2 P_2, Fig. 2.



Regulator for Controlling Engines from Bridge.

(Two separate guide slot plates are shown to bring out principle.)

The figures show the regulator in mid-position with the steam shut off and the links half up. The shape of the slots and their relation to each other would be determined by the particular type of engine, but would be designed for the most efficient and safest handling. The location of the regulator engine would be such as to allow the shortest and simplest connections with the engine-room telegraph. It could be under the engine-

room floor or where least in the way. The location of the sliding frame would be close to the engines, where least in the way, against a bracket shelf on a bulkhead, under the engine-room floor, or overhead—the location, except for convenience, being immaterial. The motions from the cams to the reversing engine and the throttle are communicated by bell-cranks or other suitable connections.

The auxiliary machinery, such as circulating and air pumps, can be controlled with but little trouble by additional slots and cams. In fact, all routine movements now performed by hand successfully can be arranged to take place at the exact time required for efficient working without the possibility of mistakes.

No provision is made for the sending of any return signal to the bridge while working automatically, as the motion of the engine will show on the "engine indicators" in the pilot-house, and will be the best and surest indication that can be devised.

In case it be assumed that the engine telegraph cannot be made strong enough, or the friction of the valve with its resistance reduced sufficiently, the valve on the regulator engine can be made to move by a lever of sufficient power, connected with the valve by means similar to, but lighter and simpler than, the connections to the steering engine in the steering-engine compartment.

The primary object of the automatic working of the main engines directly from the dock is increased efficiency. Time will be saved by its use, as well as the elimination of the chance of accident from misunderstanding or faulty execution of signals. Such mistakes have happened with the best men at the throttle, and may happen again. The power of working the engines at all times may be of vital importance. A small piece of a projectile during battle might cut even a small auxiliary pipe filled with live steam, which might make an engine-room uninhabitable before steam could be shut off. The destruction of the draught might fill the compartment with poisonous gases. During the time the engine-room was thus cleared of living beings, might occur a critical moment when the safety or destruction of the vessel would depend on the handling of the engines promptly. The plan proposed would allow the engines to be controlled the same under such conditions as at any other time.

In a vessel dependent on the motion of the engines for propulsion, the importance of the proper working of the machinery at all times, but especially in action or in times of danger, cannot be overestimated. A collision or a torpedo explosion might result in such danger to those below decks that the engine-room would be cleared on account of the possibility of going down with the ship. Control of the engines from the deck would prevent the loss of life due to the vessel sinking while going through the water, or carrying down those remaining at the post of duty in the engine-room.

Various changes will suggest themselves to experts looking over the details of the plan here proposed for speed control. The details as given may appear cumbrous, as the one idea has been to make the principles clear, and this could be done only by sacrificing small details to bring out the general effect. Keeping the reversing engine available for use when desired has also added unnecessary parts. When once the principle is adopted there will be time and opportunity for introducing improvements in many directions to save room and get rid of useless parts.

The following are some of the advantages which would attend the adoption of automatic control of engines :

1st. Avoidance of errorr and accidents due to misunderstanding or poor execution of signals from deck.

2d. Quicker working of the main engines, since the motion of one lever on the bridge acts directly on both the reversing engine and the throttle. The engine will be worked in the same time it now takes to make the signal.

3d. Complete control of the engines while steam is in the boilers, in case an accident to a steam-pipe or the draught makes the engine-room untenable, or a serious incident, such as being rammed or torpedoed, forces those in the engine-room to leave their post.

4th. Greater efficiency in handling the engine with increased security from accidents due to imperfections in the machinery or its working, by allowing those now stationed strictly on the engine platform when under way to move freely about the engine-room, inspecting all parts more frequently.

5th. Relief from constant strain of those now stationed to watch engine-room telegraph when under way.

6th. Adaptability to any form of engine without lessening usefulness of present system of reversing engines by hand.

7th. Ready return to existing style of working engine when so desired.

8th. Adaptability of present connections of engine telegraph to new system of working engines without any increase in number of parts or the use of untried systems of connection.

9th. Exact and delicate adjustments of speed to suit the exigencies of squadron evolutions in close order.

A Water Power and Compressed Air Transmission Plant for the North Star Mining Company, Grass Valley, Cal.*

BY ARTHUR DE WINT FOOTE, M. AM. SOC. C. E.

Upon the prohibition of placer mining by the State of California, the immense canal systems extending over the western slopes of the Sierra Nevadas were left without a purpose, and their future existence depended upon a new use for water. Out of this necessity has grown a business of selling water for power and irrigation, retaining the original methods of delivery at the bank of the canal and miner's inch measurement. The price of water is approximately 1 cent per 1,000 gallons, delivered at the canal; its cost for power depends upon the pressure that can be obtained from it. In the case of the North Star plant, it could have been conveyed directly to the mines and have done its work there on different wheels more or less adapted to the varying conditions; but there is a certain inconvenience and danger in using water in this manner under a high pressure, and, moreover, the mines are on a hill. So it therefore seemed advisable to convey the water directly to the lowest convenient point, obtain the power there, and transmit this power to the places where it was needed.

This brought forward the subject of transmission of power, and electricity was naturally suggested first. Visits to mines in operation and careful study and investigation of electrical appliances for underground work, especially pumping, finally decided the author in favor of compressed air. The latter method, under the conditions, was believed to be most economical of power, least liable to accident and cheapest in first cost. Moreover, almost absolute security against stoppage could be obtained by having a set of boilers on hand ready for firing up in case the water power or air plant gave out, for, by the use of these boilers and opening and shutting a few valves, all the air motors become equally good steam motors; whereas, with electrical transmission an entire set of steam motors would have to be provided to give equal security; or as the air and steam motors are the same, the electrical motors would require just so much extra expense in cost of plant of equal security against stoppage.

The water supply is obtained from the South Yuba Water Company, at a point on their canal about four miles from Grass Valley, Nevada County, Cal. Thence it is conveyed about 2½ miles to the Empire Mining Company's works in a 22-inch riveted iron pipe, built more than 10 years ago. The new conduit is a riveted steel pipe, 20 inches in diameter, joined to the lower end of this old one under a head of 420 feet, and continues 7,070 feet to the power-house, situated at the lowest convenient point on Wolf Creek, just below the town of Grass Valley, where a head of 775 feet, or a static pressure of 335 lbs. per square inch, is obtained. The capacity of this pipe is sufficient to develop 800 to 1,000 horse power.

At the power-house there is a Pelton water wheel, 18 feet 6 inches diameter, running on a 10-inch shaft, to which a duplex compound air compressor is connected directly. The inital cylinders are 18 inches, and the second cylinders are 10 inches in diameter, with a 24-inch stroke. They were designed to run at 110 revolutions per minute, and require 283 horse power from the water wheel.

A six-inch lap-welded pipe conveys the air at 90 pounds pressure from the power-house to the company's Stockbridge shaft on Massachusetts Hill, 800 feet distant and 125 feet higher. Here it is now being used in a 100 horse-power cross-compound Corliss pneumatic hoisting engine, and a 75 horse-power compound pump, beside other pumps, blacksmith forge, drills, etc.

The Pipe Line.—The line of the pipe is quite crooked, both horizontally and vertically. It is laid in a trench four feet deep, dug with plows and scrapers, except where too stony, and the joint holes were dug by hand. The total cost of all the work of burying the pipe, including covering a large portion of it with stone from the mine dumps, and cement masonry wells for the valves and for sustaining the pipes around bends, amounted to approximately $6,756.27. This was done on company account, after refusing bids, the lowest of which would have amounted to about $8,500. An aqueduct of cement masonry across Wolf Creek at the power-house is not included in this estimate, but was built on company account, and cost $1,435.

The Risdon Iron and Locomotive Works of San Francisco manufactured the pipe from the 48 by 66-inch sheets (rolled by the Central Mills of Harrisburg from slabs furnished by the Pennsylvania Steel Company) and laid it complete in lengths of about 28 feet in the

* Abstract of a paper read before the American Society of Civil Engineers, June 28, 1896.

trench under the following schedule, the longitudinal seams being double riveted by hydraulic riveters:

Head in feet.	Length.	No. B. W. G.	Thickness.	Rivets.	Remarks.
420 to 500	2,320 ft.	9	0.148 in	3/4 in.	Cold riveted
500 to 600	2,110 ft. 6 in.	8	0.165 in.	3/4 in.	"
600 to 700	1,158 ft.	7	0.180 in.	7/8 in.	"
700 to 750	1,204 ft.	6	0.203 in.	1/8 in.	Hot riveted
750 to 775	285 ft.	5	0.220 in.	1/8 in.	"
Receiver	40 ft.	... .	0.375 in.	1/8 in.	"

The pipe was dipped, after being made into lengths, into the usual hot asphaltum mixture and P. & B. paint was used to cover all surfaces not protected by the asphaltum when the pipe was in place.

About 1,000 feet from the lower end a 12-inch branch with a gate is put in for possible future use, and near it is a 20-inch gate. At the lower end of the pipe in the power-house there is another 20-inch gate, below which is a 12-inch branch leading to the Pelton wheel, and and adjoining this is the receiver, 2 feet in diameter, on which are the air chambers, charging tube and relief valve. The air chamber is a 10-inch lap-welded tube 18 feet long standing on the receiver, with an 8-inch gate between. The charging tube is similar, but 8 inches in diameter. Both have 2-inch water discharge pipes and gates, and by proper manipulation of the gates and the operation of inlet check valves on top of the tubes, the air chamber may be filled. Ordinarily the charging-tube is filled up to 90 pounds pressure from the air compressor delivery pipe, and then raised by the water pressure. It is found necessary to put in about one-tenth of the volume of the air-chamber every day. Where the air goes is, thus far, a mystery, as no leak has been discovered.

Water Wheel.—The demand for direct action under a head of 775 feet made a large wheel necessary in order to obtain the proper peripheral speed of half the spouting velocity. The manufacturers objected seriously to undertaking anything over 15 feet in diameter; whereas the proper speed of 60 to 70 revolutions for the compressors required a wheel of nearly 30 feet diameter. A compromise was finally made with a wheel of 18 feet 6 inches diameter, and a compressor revolution of 110 per minute, and the Pelton Water-Wheel Company, of San Francisco, built the wheel from a design by Mr. E. S. Cobb. Had the design been prepared sooner, the wheel could have been made 30 feet in diameter equally well. The Pelton Company guaranteed an efficiency of 85 per cent. at full load, and an average of 75 per cent. from half to full load of the theoretical power of the water, and, at the same time, to so govern the wheel that it should not exceed 120 revolutions nor raise the air pressure above 105 pounds per square inch in case of accident to machinery or sudden shutting off of air. The rim is built up of angles and plates riveted together to break joints. It weighs about 6,800 pounds, and is held concentric with the shaft by 12 pairs of radial spokes of 1¼-inch rod iron held by nuts to the cast-iron hub. The driving force, being applied to the rim, is transferred to the hub by four pairs of 2-inch iron rods, so arranged as to form a truss. The wheel is set on a 10-inch shaft, having a disk crank on either end and connected directly to the compressors. The regulator is a floating valve actuated against excessive velocity by the ordinary ball governor and against excessive air pressure by a spring set to move when the air pressure in the delivery pipe exceeds 90 pounds.

Repeated tests which checked very closely give the wheel an efficiency of a trifle over 90 per cent. for one-quarter, one-half, three-quarters and full loads. Between these points it is somewhat less, as the hood coming down over the nozzle tends to deflect the water as well as hold it back, and decreases the efficiency. It seems probable that the long radius of the wheel accounts for the high efficiency.

Compressors.—Mr. E. A. Rix, of San Francisco, who has made a careful study of air compression, designed the compressors, and they were built by the Fulton Engineering and Ship-Building Company of San Francisco. They are made very heavy, to stand the high piston speed required by the conditions of the water power. Had it been known at the time of designing this plant that a wheel could have been made like the one described, a diameter of 30 feet instead of 18 ft. would have been chosen and the piston speed of the compressors reduced accordingly. The compressor cylinders are 18 and 10 inches in diameter and 24 inches stroke.

The most novel feature of these machines is the intercooler. This is made up of 49 soft copper pipes, 1 inch in diameter, 18 feet long, each with a stuffing box at each end connected with manifold castings. The air delivered from the first cylinder into one manifold passes through these pipes to the other manifold, from which it is taken to the second cylinder. The whole is placed in the wheel pit directly under and in front of the wheel, so that the water dashes all over and through it. The air, leaving the first cylinder at a temperature of 200 degrees Fahr., passes through the intercooler and enters the second cylinder at 60 degrees, slightly cooler than when entering the first cylinder. The temperature is again raised to 204 degrees on leaving the second cylinder and passing into the transmission pipe, showing a total rise in temperature of 289 degrees Fahr.

The transmission pipe, conducting the air at 90 to 100 pounds pressure about 800 feet from the compressors to works at the mine, is ordinarily well tubing 5¾ inches in diameter inside. At the mine there is the ordinary air receiver and also three 50-horse power boilers set ready for steam, which are used for receivers.

The air is taken from these into the reheaters designed by Mr. Rix and built by the Fulton Company. It requires a little over half a cord of good pine wood each 24 hours to heat about 700 cubic feet of free air per minute to a temperature 350 to 400 degrees Fahr. The heated air passes through pipes covered with magnesia and hair felt to the first cylinder of the hoisting engine, from which it is exhausted back into the upper heater, where its temperature is again brought to 350 degrees, whence it passes to the second cylinder at 30 pounds pressure. From this it is exhausted through a flue to the change house, where it is used for heating and drying clothes. From the first heater also the air for the pump is conveyed some 300 feet down the shaft in a similarly covered pipe. It receives the air at about 275 degrees and exhausts it into the shaft at about 60 degrees, thus giving plenty of pure cool air to the men, without the usual fans or ventilators.

There is a direct-acting donkey pump situated in another shaft 750 feet distant, to which air is carried cold in a 2-inch pipe over the surface. An old hot water heater is used as a reheater for the air, and consumes 12 sticks of pine cord wood per 24 hours.

The hoisting engine is a compound direct-acting Corliss of 100 horse power with cylinders jacketed for hot air, and is calculated to work 3,000 feet down an incline of about 35 degrees.

Efficiencies.—The plain tale is this. There is 304 theoretical horse power in the water used at the power house, the work actually accomplished at the mine amounts to 203 horse power, and the cost of reheating is $3 per day.

Efficiency of compression and transmission from water wheel to motors, and not including cost of reheating..... $\frac{225.32}{283} = 79.5$ per cent.

Efficiency of compression and transmission from theoretical power of the water to the motors, and not including cost of reheating..... $\frac{225.32}{304} = 74$ per cent.

Efficiency from the water wheel to and through the motors, not including reheating..... $\frac{202.7}{283} = 71.6$ per cent.

Efficiency from the theoretical power of the water, to and through the motors, and not including the cost of reheating..... $\frac{202.7}{304} = 66$ per cent.

Efficiency of compression and transmission from water wheel to motors, including the cost of reheating expressed in water power..... $\frac{225.32}{307.66} = 73$ per cent.

Efficiency of compression and transmission from the theoretical power of the water to the motors, including the cost of reheating expressed in water power..... $\frac{225\ 32}{329} = 68.4$ per cent.

Efficiency of compression and transmission from the water wheel to and through motors, including cost of reheating expressed in water power..... $\frac{202.7}{307.66} = 65.5$ per cent.

Efficiency of compression and transmission from the theoretical power of water to and through the motors, including cost of reheating expressed in water power..... $\frac{202.7}{329} = 61.6$ per cent.

Horse power of air at works after reheating..... 225.32
Horse power delivered to compressors by water wheel 283
Theoretical horse power of water used on the wheel..... 304
Horse power of work actually done by the motors..... 202.7

The horse power delivered by the water wheel to the compressor, to which is added the horse power (24.66) which the cost of the wood used in reheating would buy in water..... $307.66 = 283 + 24.66$

The theoretical horse power of the water used on wheel added to the horse power (24.66) which the cost of the wood used in reheating would buy in water..... $329 = 304 + 24.66$

It may be urged that the conditions are particularly favorable to compressed air, as the transmission is short and the power is not needed for tramways or lighting. But were it 20 miles instead of 1,000 feet, it is thought by the author that, taking the whole plant, compressor, transmission pipe and motor, as against generator, transmission wires, transformers and electric motors, the air will prove cheaper in first cost, higher in efficiency, less liable to accident, and less expensive to operate and maintain.

THE MOST ADVANTAGEOUS DIMENSIONS FOR LOCOMOTIVE EXHAUST PIPES AND SMOKESTACKS.*

BY INSPECTOR TROSKE.

(*Continued from Page 137.*)

We will now compare the full-length waist-shaped stacks with those that have been shortened, so that we will obtain values similar to those brought together above. As an example of the full-length stack, we take one with a diameter of 14.76 inches, an inclination of $\frac{1}{12}$, a nozzle distance of 18.9 inches and one 15.75 inches in diameter, an inclination of $\frac{1}{12}$, nozzle distance 30.71 inches, and shortened 11.81 inches; also one shortened like the above 11.81 inches, but having a diameter of 14.76 inches, an inclination of $\frac{1}{6}$, a nozzle distance of 18.9 inches, and one 15.75 inches in diameter, shortened 17.8 inches, the inclination being $\frac{1}{6}$ and the nozzle distance 24.88 inches. These are grouped in Table XX.

TABLE XX.

		Full length. Waist diameter = 14.76 inches.	Shortened 11.42 inches. Waist diameter = 15.75 inches.
	Inches.	Inches.	Inches.
Inclination $\frac{1}{12}$: D = 18.11, d = 14.76, d_1 = 15.75	Nozzle diameters	3.94	3.25	3.15
		4.74	4.06	3.94
		Shortened 11.81 inches.	Shortened 17.80 inches.
	Inches.	Inches.	Inches.
Inclination $\frac{1}{6}$: D = 19.49, d = 14.76, d_1 = 15.75	Nozzle diameters	3.94	2.13	2.11
		4.74	2.83	2.76

Further examples are also given by the diagrams of Plates III. and IV. as well as by the group of stacks given in Fig. 41.

The preceeding values for the vacuums were obtained entirely independently of each other, on the experimental apparatus, and in each group of stacks comparisons are made with equal nozzle diameters. The difference of a few hundredths of an inch can make no real difference in practice. Hence we may draw the following conclusion:

The shape of the foot of the stack is, for about the lower third of the total height of the stack, without any noteworthy influence upon the action of the air, provided that the current of steam with its surrounding mantle of air finds a free entrance into the stack.

It is, therefore, practically speaking, a matter of no importance whether the base of the stack is cylindrical or conical in form, provided only that it is large enough. In this connection, it may be said that in locomotive practice we frequently find a conical stack setting upon a cylindrical base. It is always well, however, to use a slightly wider foot under a conical stack, since, when steam is being raised as well as when the locomotive is running without steam, it creates a slight draught of the products of combustion.

(c.) *Condensations Emitted from the Experimental Stacks.*

A peculiar phenomenon connected with these experiments with the apparatus was the shower of condensed water blown from the stack and which has already been mentioned in Section II. It started from a certain position of the nozzle. Lower temperature affected the shower somewhat, but in the hottest months of the summer there was but comparatively little difference. The larger the nozzle opening the earlier the phenomenon appeared, that is to say, the shorter the nozzle distance up to the smallest section.

The shower usually began feebly, increased with the decreasing distance of the nozzle and finally degenerated into a perfect downpour of water. From this it appears that the current of steam assumes the shape of a cone, and in cylindrical or slightly conical stacks it impinges sharply against the sides, and is here partially condensed, and that a portion of the water that is mingled with the jet is also thrown against the sides. This contact gains in force the shorter the nozzle distance and the smaller the upper diameter of the stack, as compared with its total length measured from the nozzle. The greater the flare of the stack the later does the shower begin and the weaker it is, the smallest diameter remaining the same. For example, take a nozzle diameter of 4.74 inches, with a stack having an inclination of $\frac{1}{6}$ and a minimum diameter of 15.75 inches, with a nozzle distance of 3 feet 8.11 inches, and compare it with a stack having an inclination of $\frac{1}{12}$ and a minimum diameter of 29.92 inches. Table XXI. gives the results of such a comparison.

* Paper read before the German Society of Mechanical Engineers, and published in *Glasers Annalen fur Gewerbe und Bauwesen.*

TABLE XXI.

Stack diameters. inches	Nozzle locations in inches, at which the discharge of condensation was first observed, for nozzle diameters of									
	3.94 inches.		4.33 inches.		4.74 inches.		5.12 inches.		5.51 inches.	
	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination	Stack of $\frac{1}{12}$ inclination	Stack of $\frac{1}{6}$ inclination
11.81	18.90	23.62	18 90	22.05	18.90	18.90	18.90	18 90	18.90	18.90
12.80	22.05	29.92	20.47	26.77	18.90	22.05	18.90	20.47	18.90	18.90
13.78	26.77	36.22	25.20	33.07	20.47	26.77	18.90	25.20	18 90	23.62
14.76	33.07	40.94	29.92	39.37	23.62	33.07	18.90	31.50	18.90	28 35
15.75	39.37	47.42	36.22	45.67	29.92	44.11	23.62	42.52	18.90	40.94

Remarks: Cylindrical stacks of from 13.78 inches to 15.75 inches in diameter began to throw water at a nozzle position of 18.9 inches, but when the diameter was increased to 14.76 inches, the first water appeared at 20.47 inches, the nozzle diameter in both cases being 3.94 inches, and at 15.75 inches diameter with nozzles of 3.94 and 4.33 inches diameter water appeared at 22.05 inches for the first and 20.47 inches for the second.

It may be remarked, that, in consequence of faulty observation, the first appearance of water may possibly have occurred earlier here and there, than is indicated in this table.

In these experiments, that position of the nozzle was always recorded at which the first drops of water were thrown in a circle from the mouth of the stack. It was also recognized, that for a given stack, when this began, the diameter was already too small for the size of the nozzle or the nozzle distance was too great.

In order that we may obtain dimensions that are serviceable from Table XXI., we must always keep the nozzle below the point where water appeared, which means that we must choose a nozzle position for a lower efficiency than that given in the tabie. (The rules given in Section III. on the determination of the nozzle position supply values which underlie the tabulated figures.

Similar experiments conducted with locomotives show this throwing of water to be only occasional with small stacks, and even then it does not occur in any great quantity. The reason for this is simply that the current of steam is surrounded by an envelope of the hot products of combustion by which it is partially dried and by which the sides of the stack are also heated.

It was further shown that the same stack, which threw quantities of water from the apparatus, was even more strongly inclined to throw sparks from the locomotive. The latter may be taken to be due, in the first place, to the vacuum being too high, but it is also dependent upon the depth of the bed of the fire, the kind of fuel used (whether coarse or fine, smooth or gritty, wet or dry), also the size of the grates and the air passages between the bars; the number, diameter, and length of the tubes, and the running speed, all of which are matters of considerable importance; the reason for which is that because, in general, the faster the speed the weaker the impulse of each exhaust, although they follow each other with greater rapidity, therefore the draft is more even and gentle than where there is a greater interval between the impulses. But according to all observations the ratio existing between the stack and the nozzle exerts an influence of the first order. A stack that is too large relatively to the diameter of the nozzle cannot exceed and may not even equal the vacuum produced by a smaller stack and a larger nozzle.

A larger stack has a further advantage in comparison with a smaller one on account of its efficiency in tending to free the tubes from dirt, for, in raising steam in a locomotive, the products of combustion are more easily passed through it, and while running down long grades without steam with the engine reversed, the injurious sucking of the smokebox gases into the cylinder is greatly modified.

A connection between the water thrown from the apparatus and the sparking on a locomotive seems to lie in the fact that the water throwing was merely a characteristic of the stacks with which the experiments on the apparatus were conducted. If, under practically the same conditions, one stack gives a higher value for the vacuum than another, the first, regarded independently of the absolute size of the stack, is superior to the other from a practical standpoint, if it does not throw water from the apparatus or spark more or less upon the locomotive. From this we conclude that,

The absolute value of the vacuum is not the determining feature in settling the efficiency of the shape of the stack.

A few examples will assist in making this clearer:

1. As the first fruits of the experimental apparatus were produced we found that, with a nozzle opening of 4.74 inches and a location of 21.65 inches below the bottom of a stack having an inclination of $\frac{1}{12}$, the vacuum produced was superior to that of a stack having an inclination of $\frac{1}{6}$, a fact which was proved on a few

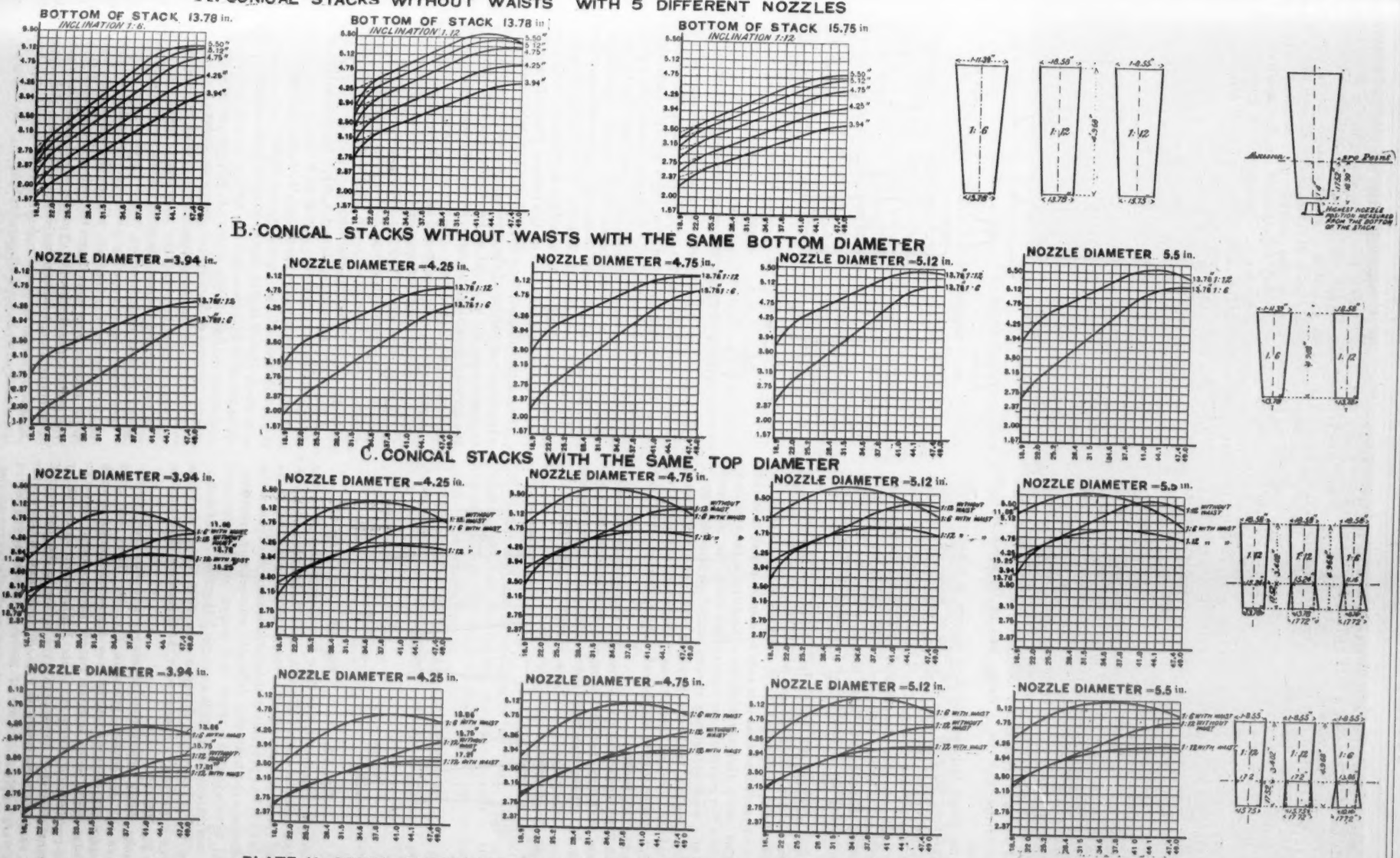

A. CONICAL STACKS WITHOUT WAISTS WITH 5 DIFFERENT NOZZLES
BOTTOM OF STACK 13.78 in.
INCLINATION 1:6.
BOTTOM OF STACK 13.78 in.
INCLINATION 1:12.
BOTTOM OF STACK 15.75 in.
INCLINATION 1:12.
B. CONICAL STACKS WITHOUT WAISTS WITH THE SAME BOTTOM DIAMETER
NOZZLE DIAMETER =3.94 in.
NOZZLE DIAMETER =4.25 in.
NOZZLE DIAMETER =4.75 in.
NOZZLE DIAMETER =5.12 in.
NOZZLE DIAMETER 5.5 in.
C. CONICAL STACKS WITH THE SAME TOP DIAMETER
NOZZLE DIAMETER =3.94 in.
NOZZLE DIAMETER =4.25 in.
NOZZLE DIAMETER =4.75 in.
NOZZLE DIAMETER =5.12 in.
NOZZLE DIAMETER =5.5 in.
NOZZLE DIAMETER =3.94 in.
NOZZLE DIAMETER =4.25 in.
NOZZLE DIAMETER =4.75 in.
NOZZLE DIAMETER =5.12 in.
NOZZLE DIAMETER =5.5 in.

PLATE V.—DETAIL DIAGRAM OF THE HANOVER SMOKE-STACK AND EXHAUST NOZZLE EXPERIMENTS.

NOTE 1.—All observations with the water column were made with the same steam pressure (equal to 3.94 in. of mercury), and with exactly the same air openings.
2.—The abscissas (nozzle distances) are taken with stacks having no waist from a point 17.52 in. above the smallest section and 18.90 in. above the highest position of the nozzle.
3.—Curves of stacks 15.24 in.—1:12 (with waist) and 17.2 in.—1:12 (with waist), are taken by interpolation from Plate I.

locomotives in service. These had conical stacks, with an inclination of $\frac{1}{8}$, a diameter of 13.78 inches, a nozzle 4.74 inches in diameter, located 19.68 inches below the bottom. A sheet-metal lining with an inclination of $\frac{1}{12}$ was built into this stack of $\frac{1}{8}$ inclination on the locomotive, as shown by the dotted lines of Fig. 45. Then, instead of the efficiency rising, as would have been expected, it not only remained the same, but was accompanied by a few other circumstances. The locomotive exhibited a tendency to throw sparks and, according to the driver, an inclination to eject water as well. In consequence of this the lining was removed and it was decided to substitute for the lining with its $\frac{1}{12}$ inclination a stack of $\frac{1}{12}$ inclination and having a larger bottom diameter. Instead of 13.78 inches it was made 15.36 inches.

In the same way two express locomotives having nozzles 5.51 inches in diameter, located 19.68 inches below the bottom of the stacks which had a diameter of 15.75 inches and an inclination of $\frac{1}{8}$, were fitted with cylindrical linings. Although a higher vacuum was obtained with the cylindrical stack on the apparatus than with stacks of either $\frac{1}{8}$ or $\frac{1}{12}$ inclination, and consequently it would have made a similar showing with those of $\frac{1}{8}$ inclination, the lining was not kept upon either locomotive, since it developed the same peculiarities that the $\frac{1}{12}$ lining had in the stack of 13.78 inches diameter.

The reason for these failures was first shown at a later period, when the connection between the throwing of water on the apparatus and the sparking on the locomotive was discovered. We can now, without any further explanation, and with the aid of Plate II. and Table XXI., see that the stack of 13.78 inches diameter, an inclination of $\frac{1}{12}$ and a nozzle diameter of 4.74 inches, threw water when the nozzle distance was 20.47 inches, while, on the other hand, the one having an inclination of $\frac{1}{8}$ showed its first water at 26.77 inches.

In the same manner the cylindrical stack, 15.75 inches in diameter, threw water with a 5.51 inch nozzle located at 18.9 inches, and at the same point the conical stack, with an inclination of $\frac{1}{12}$, threw water and sparks, so that it is safe to consider that this will begin at shorter nozzle distance with the cylindrical stack, while a stack of $\frac{1}{8}$ inclination (drawing our conclusions from the performance of the one with $\frac{1}{8}$) neither throws water nor sparks at 19¾ inches. Hence, as we shall see later, it will not do to use a cylindrical stack of the same diameter as the smallest, having an inclination of $\frac{1}{8}$, but it should be somewhat larger, that is about 16.9 inches instead of 15¾ inches.

2. A few old Erfurt passenger and freight locomotives were in the main shops at Templehof and equipped with stacks like that shown in Fig. 46. These were replaced by others like those shown

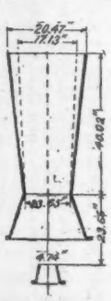


Fig. 45.

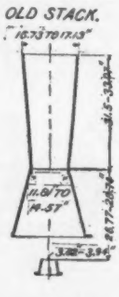


Fig. 46.

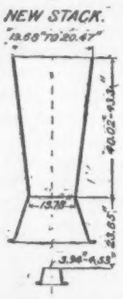


Fig. 47.

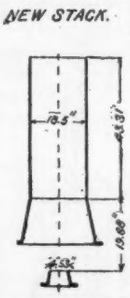
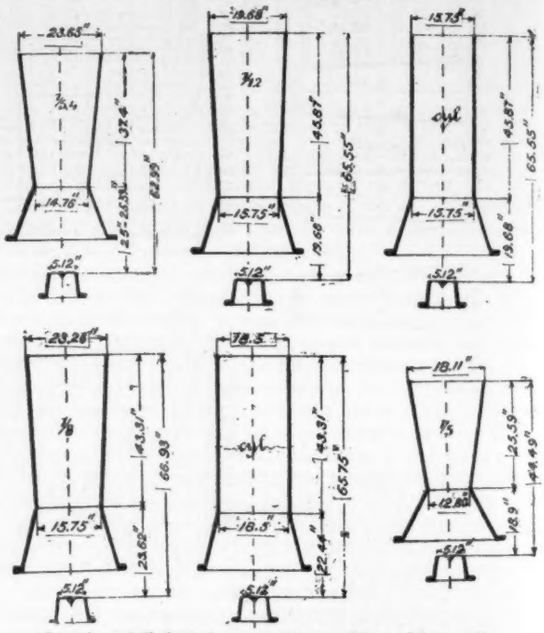


Fig. 48.

in Figs. 47 and 48. The result was that the locomotives with the larger stack and shorter nozzle distance tore their fires very much less and were better steamers than before. Also in a few of these locomotives which had previously shown a tendency to heat the smokebox sheets to red heat, that difficulty was entirely overcome.

Table XXI. shows that the stack 11.81 inches in diameter, and having an inclination of $\frac{1}{8}$ with a nozzle 3.94 inches in diameter, threw water when the nozzle distance was 23.62 inches, and this would be even more likely to occur with the distance of 28.74 inches, as shown in Fig. 46.

3. The stacks of the new Erfurt passenger and fast freight locomotives have the dimensions given in Fig. 49. They are good steamers, and when working easily they throw no sparks, though they probably would with a later cut-off (25 or more). In order that the observations set forth in Table XXI. might be tested by actual locomotive service, five stacks were made in the last-named workshops, that are illustrated by Figs. 50 to 54, and in the winter of 1895 they were applied to two of these locomotives and tested under unfavorable conditions of weather with the same nozzles, which had a diameter of 5.12 inches, with a bridge .31 inches wide across the opening, thus making it the equivalent of a nozzle 4.94 inches in diameter. With the stack shown in Fig. 50 the locomotive steamed better than before, but it also threw more sparks. The latter feature was true to a still greater extent when they applied the cylindrical stack 15.75 inches in diameter, that is shown in Fig 51, which was on that account soon removed. The spark throwing diminished very considerably on tho application of a waist of the same diameter in connection with a conical portion having an inclination of $\frac{3}{8}$, as shown in Fig. 52, and a cylindrical with a diameter of 18½ inches, as seen in Fig. 53.



Stacks of Erfurt Locomotives—Figs. 49 to 52.

The generation of steam with both stacks was also so good that the driver asked to have the experimental stack left upon the engine. Finally with the form illustrated by Fig. 54 the throwing of sparks reached its maximum. It was to have been foreseen that the stack in question should not give the best results, but rather serve as a proof of the assertions made above. On account of the small diameter of the waist it was necessary, according to Plate I, to diminish its length to 25.59 inches with a nozzle distance of 18.9 inches, thus making the total height 44.49 inches, with a very rapid flare, measurements chosen on the basis of Plates II. and III.

Throughout the fourteen days of the test, which was during an unfavorable condition of the weather, the stack caused the engine to steam well, but of all six of the stacks that were tried it threw the greatest quantity of sparks, as we have already said, as well as unburned particles of coal.

A comparison of the curves of this stack as shown in Plate II., in which we bring together and observe stacks with inclinations of $\frac{1}{8}$, 4, $\frac{1}{8}$ and $\frac{1}{8}$, and see that by the application of a bridge to the mouth of the nozzle the water throwing begins with a shorter nozzle distance than that given in Table XXI.; this comparison then gives the following results:

A stack of 14.76 inches diameter, with an inclination of $\frac{1}{8}$, and a nozzle distance of 25 inches, threw no water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{12}$ and a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, cylindrical in form, with a nozzle distance of 19.68 inches, threw water.

A stack of 15.75 inches diameter, with an inclination of $\frac{1}{8}$ and a nozzle distance of 23.62 inches, threw no water.

A stack of 18.5 inches diameter, cylindrical in form, and a nozzle distance of 22.44 inches, threw no water.

A stack of 12.8 inches diameter, with an inclination of $\frac{1}{8}$ and a nozzle distance of 18 9 inches, threw water.

The three water-throwing stacks here indicated are the same that upon locomotives in service, threw the most sparks, and which were also the ones that began throwing them the first, while, with the other three stacks, the opposite set of conditions prevailed.

A connection between water-throwing on the apparatus and spark-throwing on the locomotive has, therefore, been demonstrated to exist beyond all peradventure.

(To be Continued.)

Fig. 1.—Perspective View of the Brill Passenger Truck.

A "Perfect" Truck for Passenger Cars.

During the recent conventions, which were held at Saratoga, Messrs. J. G. Brill & Company, of Philadelphia, exhibited a very well made model of a new truck which they are now introducing on steam and electric roads, and which has some novel features, and for which some important advantages are claimed.

Fig. 1 represents a prospective view of one of these trucks, Fig. 2 is a side view, drawn in outline, Fig. 3 a diagrammatic cross-section, and Fig. 4 a view of an elastic swing-hanger, which is one of the peculiar features of the truck.

shown between the two front wheels in Fig. 1. The interior springs are double elliptics, but, of course, spiral springs could be used if it was thought desirable to do so. Two, three or four such springs may be used on each side.

From the description it is obvious that the spring-plank and equalizers can all swing laterally in the stirrups, which form spring swing-links. The load rests primarily on the interior elliptics, or whatever kind of springs are used in that position. It is then transmitted to the spring-hangers, and from them to the journal springs. This gives a very great degree of elasticity to the truck, and enables it to adjust itself with a minimum amount of

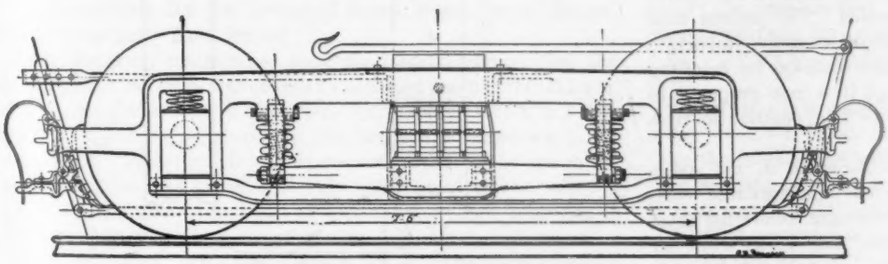


Fig. 2.—Side View of Brill Passenger Truck.

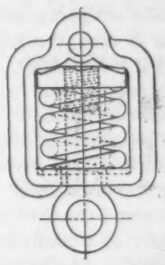


Fig. 4.—Elastic Swing Hanger.

The principle of the construction of the frame resembles that which has so long been adopted for locomotive frames. For steam cars they are forged, and for electric roads they are cast of steel.

The top bar or wheel piece consists of a single bar, which extends from one of the journal boxes to the other, as shown in Figs. 1 and 2. On this bar jaws are forged or cast to receive the journal boxes and on the outermost ones an extension is added to which T-iron end pieces are bolted, which connect the two frames together, and from which the brake beams are suspended. The upper or main bar of the frames have lugs forged on them between the jaws and as near to them as may be practicable. To these the swing links are attached. These are of a somewhat peculiar construction, which is shown clearly in Figs. 1 and 4. They each consist of an open cast-steel stirrup, which receives an eight-inch spiral spring, having a follower nut on top, into which an eyebolt is screwed, the lower end of which is connected to the equalizing lever. The stirrup has an eye in its upper end, by which it is attached by a bolt to the lugs on the wheel piece. The weight which is carried by the equalizer is transmitted to the eyebolt and thence to the spring, which acts as an elastic bearing, at the same time the stirrup can swing laterally on the bolt which passes through its upper end, as indicated on the left side of Fig. 3. The equalizers are made with pivotal ends, which enter the eyes on the lower ends of the stirrups.

The spring-plank consists of two Z-shaped bars, shown by dotted lines in Fig. 2, and filled with wood. These are rigidly fastened to the equalizers, which can swing on the stirrups or links, and the spring-plank moves with it. The transoms consist of angle-iron bars, which are fastened to lugs on the forged frames, but in the cast-steel frames are fastened by angle plates, one of which is

disturbance to the inequalities of the track. The equalizers have also the effect of distributing the load equally on the two wheels on each side of the truck, no matter what the vertical position of any of the wheels may be.

Owing to the fact that the load primarily rests on the equalizers, and by them is transmitted to the main frames at points close to

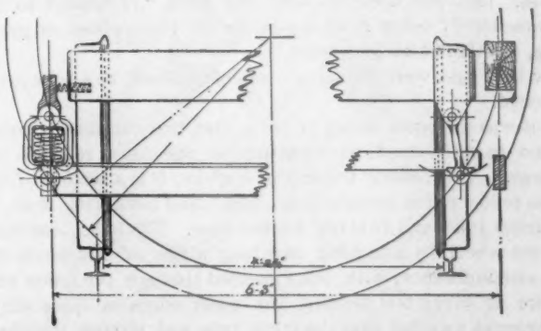


Fig. 3.—Brill Passenger Truck.

the jaws, these frames are subjected to less strains than they would be if the load rested on them about midway between the wheels. The T-iron end pieces and the attachment of the transoms to the wheel pieces or side frames affords a very effective means of holding the truck square.

The result of the lateral and vertical adjustibility of these trucks is that they are reported to have great "adherence" to the track

that even on very rough roads they have been found to be safe, and to ride with great ease and comfort to passengers. Messrs. J. G. Brill & Company, the well-known car builders of Philadelphia, are the sponsors for this truck, and are now supplying it for both steam and electric roads.

The Railroad Master Blacksmiths' Association.

The annual meeting of the National Railroad Master Blacksmiths' Association will be held at Chicago, beginning at 10 o'clock, Sept. 1, 1896, at the Tremont House. A specially interesting programme of pertinent topics has been prepared. Arrangements have been made whereby they secure a rate of $2 per day at the Tremont House, which will be official headquarters. It is located on the corner of Lake and Dearborn streets, Chicago. Members will kindly notify Mr. John Buckley, of the Illinois Central Railroad shops, Chicago Ill., whether they intend to attend the convention, also if they are going to be accompanied by members of their family, and how many. This will give Mr. Buckley an opportunity to make proper arrangements with the manager of the Tremont House.

The Origin of Pneumatic Tires.

In an article in the *Indiarubber World* Hawthorne Hill says: One can readily believe that the attention of visitors to the fashionable parks in London, at a certain period just a half-century ago, was "much attracted" by the appearance among the gay equipages of a certain brougham, after reading the contemporary descriptions of the latter. The vehicle had been constructed without springs, but its chief novelty lay in certain "improvements" patented by a civil engineer of Middlesex County, named Robert William Thomson, in the shape of what he called "noiseless tires." They were, in fact, the pioneer pneumatic tires, and the inventor had boldly started out to exhibit them on the wheels of a brougham weighing nearly 1,200 pounds. The present time marking, as it does, the semi-centennial of so many important applications of indiarubber, seems a proper occasion for recalling Thomson's "patentaerial wheels," though it is not proposed to connect their invention, by any link, with the pneumatic tires which have become so successful.

"The nature of my invention," says Thomson in his specification, No. 10,990 of 1845, "consists in the application of elastic bearings round the tires of wheels of carriages, rendering their motion easier, and diminishing the noise they make while in motion. I prefer employing for the purpose a hollow belt composed of some air-tight or water-tight material, such as caoutchouc or gutta-percha, and inflating it with air, whereby the wheels will in every part of their revolution present a cushion of air to the ground, or rail, or track, on which they run."

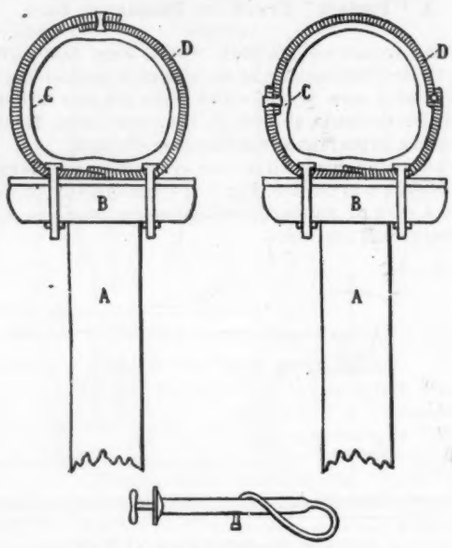
This elastic belt, as Thomson called his inner tube, was composed of several thicknesses of canvas, each "saturated and covered on both sides with indiarubber or gutta-percha in a state of solution," laid one upon another, and each "cemented to the one immediately below it by a solution of indiarubber or gutta-percha, or other suitable cement."

How the edges were joined to complete the belt as a tube is not mentioned.

But it was the outer casing or cover that first caught the public eye, and to understand its construction one must refer to the drawings. *A* represents the end of a spoke; *B* is a section of the wooden felloe, much broader than usual, and tired with steel; *C* is the inner tube, and *D* is the leather shoe. The latter was built upon the wheel by attaching two long strips of leather to the whole circumference, with bolts inserted through the felloe and steel tire at every few inches. The outer edges of these strips were brought together over the inner tube and riveted together, after which the tirewas complete.

Or a third strip of leather might be used, as shown in the drawing to the right, being riveted to one of the base pieces and laced to the other. A pipe through which to inflate the inner tube was passed at one place through the tire of the wheel, and fitted with an air-tight screw cap. In the lower drawing is shown the "condenser" used for inflating the tube. It was the size of Thomson's tires, next to the noiselessness of the wheels, that most attracted attention. They were about 5 inches in diameter, intended to be so inflated as to keep the tire of the wheel 2½ inches from the ground, which was thought to be "sufficient to admit of the wheels passing over any stones or other matters projecting beyond the general level of any ordinary turnpike road without the solid tire coming in contact with them. Wagons for the carriage of goods were expected to need tubes of a larger diameter and stronger materials.

In commenting upon the new-style of wheels, the *Mechanics' Magazine* (London), after the trial brougham had been drawn upward of 1,200 miles, without "the slightest symptoms of deterioration or decay" in the tires, had this to say: "It has so long been regarded as a settled thing that friction is least with hard substances and greatest with soft, that by a natural, though not perhaps strictly logical, course of induction we inferred that, though in this case the noise might be less, the friction, and consequently the tractive power required, would be greater. We must candidly own that we little expected to find the very reverse of this to be the fact. Yet so it is." Then are given the results of experiments made with Thomson's wheels in the Regent's Park by a noted firm of coach-builders, and verified by the editor,



Thomson's Pneumatic Tires.

showing the comparative lightness of draught of the "aërial" wheels, both on a smooth and firm road and on a section covered with newly broken stone.

The table follows, showing draught in pounds:

	Common wheels.	Patent wheels.	Saving by pt. wheels per cent.
Over smooth, hard road	45	28	60
Over new broken flints	120	38½	301

Evidently our pioneer inventor had given much thought to his work, for in his specification he treated at length of the variations possible in the construction of the pneumatic tire, in order to make the patent as "broad" as possible. Some of it is good reading, too, as showing the ideas he entertained with regard to the properties of air in wheel tires.

One variation of Thomson's original suggestion of an inner tube was that several tubes might be employed for a single tire—up to nine, for instance. In such cases the ordinary air-pipe would have to be dispensed with, the inflation being accomplished by means of air-screws in one end of each tube before they were laced into the leathern envelope. It was suggested that the leather might be protected from wear by covering its outer surface with flat-headed metal rivets secured on the inside with small washers.

The latter end of the "aërial" wheel is not certainly known, but tradition has it that its inventor was much laughed at. Six years after the date of his pneumatic tire patent, Thomson's name appeared in the catalogue of the Great Exhibition of London in connection with an invalid chair, of which "the wheel (in ad-

dition to an iron tire) is shod with a solid band of vulcanized indiarubber, said to be as durable as iron." As late as 1868 all the scientific journals in Europe were describing Thomson's solid indiarubber tires (5 inches thick) for traction engines for common roads.

The Freezing of Gas.

Since gas began to be adopted generally for lighting purposes it has been the aim of gas engineers to prevent the freezing in of gas pipes. Until recently it has been the general opinion that the moisture always present in lighting gas caused the freezing in by its separation in frost-like form, and all the methods known so far to prevent this are based upon the principle of removing the moisture in the gas before its entrance into the conduit pipes. The method formerly employed to reach this purpose was that the gas was exposed in so-called "freezing-out" cylinders to the cold, whereby, of course, the drying of the gas was obtained. But, as in the freezing-out cylinder, not only the moisture contained in the gas, but also large quantities of the light-giving carburated gases were separated, the frozen out gas showed such losses of lighting power that the practical employment of this method was hardly possible.

An extraordinarily simple and cheap method to dry the lighting gas by means of sulphuric acid of certain concentration was patented by the German Continental Gas Company two years ago, and proved quite satisfactory in the beginning. In the last hard winter, however, the chandeliers and conduits froze in again, although the gas entered the distributing pipes entirely free from water, and an investigation showed that the pipes were perfectly stopped up by frost-like formations in the same manner as if undried gas had been used. There was only the difference that these formations did not consist of frozen water, but of frozen, almost chemically pure, benzol.

This discovery shattered at once the former opinion that the freezing in of the pipes was caused by moisture contained in the gas, and the author very soon discovered a method by which not only the freezing of the moisture, but also that of the benzol was made impossible. The principle of this method is, that in the gas works and behind the gas meter, a certain quantity of alcohol vapor is added to the gas. The effect of this alcohol vapor is shown in the fact, that, if, by the action of the cold, separations of water and benzol occur, the alcohol vapor carried along also separates, whereby the freezing point of these separated condensations of water and benzol is forced down so much, that they will not congeal even at our coldest temperature in winter, but remain in liquid condition. They can, therefore, flow back into the main conduit and from there into the next condensing pot. A stopping up of the gas conduit by separation of solid condensations is made impossible in this manner.

The action of the alcohol vapor added to the gas is here an altogether different one of that caused by injecting liquid alcohol into frozen-up pipes. By my method a means is furnished to prevent freezing in altogether, while in the former use of alcohol in the gas works it was but intended to thaw up conduits that were frozen in already.

In the last hard winter it was shown by experiments that the action of the alcohol vapor added at the gas works is still effective at a distance of three miles—that is, the alcohol vapor remains in the gas. The action of the alcohol vapor, however, is stopped as soon as the gas has passed a wet gas meter. In the case of large establishments a small apparatus for evaporating alcohol can be provided behind the gas meter.

For practically carrying out this method a small evaporator of ordinary construction heated by steam, or a little gas flame, is used, into which the alcohol from a higher placed tank flows in a fine, instantly evaporating stream. The hot alcohol vapor is conducted through a little pipe into the gas main and at once absorbed by the gas.

In order to obtain the desired effect about five grammes of 95 per cent. denaturated alcohol must be added per one cubic meter; at very low temperature, about 10 to 20 degrees below zero, this amount must be increased by one or two grammes. In most cases it is sufficient to commence with evaporating alcohol about half an hour before the street lamps are lit, while the addition of alcohol in the day time would appear to be necessary in exceptional cases only.

This method was employed on a large scale last winter in the gas works at Dessau, where it has given excellent results. Its advantages must not be looked for in the saving of alcohol; on the contrary, in most cases more alcohol is consumed than in the old method, which aimed only at the removal of obstructions produced by freezing it. The great advantages of the new method are found in the saving of wages, and, above all, in the entire removal of interruptions in the distribution of gas, which usually occur when most disagreeable—that is, in the winter, and which are apt to discredit gaslighting during that season.—*Exchange.*

Tests of Boilers.

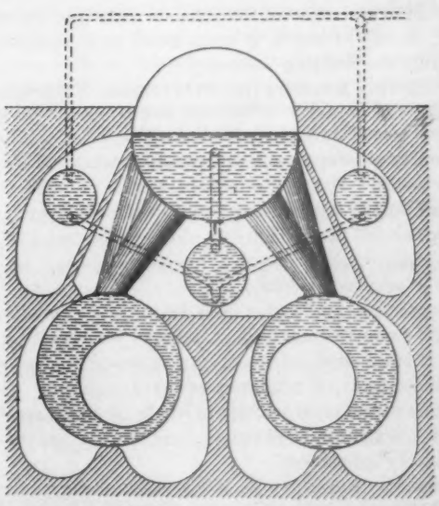
Mr. Lavington E. Fletcher, the Chief Engineer of the Manchester Steam Users' Association, some time ago made some tests of Babcock & Wilcox water tube boilers, from which he draws the following conclusions:

The table shows that the Babcock & Wilcox boilers gave, in the first series of tests, when coal was used, a mean equivalent evaporation from and at 212 degrees, when assisted by an economizer, of 8.74 pounds of water per pound of coal "as used," and 9.29 pounds of water per pound of "dry coal"; and at the second series, when gas coke was used, they gave an equivalent evaporation, when assisted by an exhaust steam feed-water heater, of 9.02 pounds of water per pound of coke "as used," and 10.07 pound of water per pound of dry "coke." These results do not justify the opinion that the Babcock & Wilcox boiler is more economical than the Lancashire boiler.

Mr. Fletcher also made a test of a "Livet Patent Steam Generator."

"This generator consists of three cylinders, one upper and two lower ones, set so as to form a triangle, when regarded either from the front or the back, each lower cylinder having a furnace tube running through it, and being connected to the upper one by a series of conical pipes. (See Figure.)

"In the generator tested by the M. S. U. A., which was a new one, the upper cylinder was 6 feet 6 inches in diameter, and the



Livet Steam Generator.

two lower ones 5 feet 9 inches in the shell, all three cylinders being 24 feet 6 inches long as nearly as may be. Each furnace tube was 3 feet 6 inches in diameter, and fitted with six conical water pipes, while the fire grates were 6 feet long by 3 feet 5 inches wide, giving an area of 41 square feet. In addition to the three cylinders just described, there were three smaller ones placed in the external brickwork flues, two of them being 25

nches in diameter, and the third 30 inches. Through these cylinders the feed water was passed and heated before entering the upper cylinders of the generator.

"The tests were made at atmospheric pressure, all the steam passing away at the manhole, which was wide open.'

From the tests it appears that no decided economy attends the use of the Livet patent steam generator, the equivalent evaporation from and at 212 degrees per pound of "dry" coal at tests No. 1 and 2 being 9.66 pounds, which is not superior to that obtained by boilers of the Lancashire type when worked under ordinarily fair conditions.

Further, the Livet steam generator requires a greater width of frontage than the Lancashire boiler. Taking the width from center to center, in a range of Livet steam generators, at 17 feet, and that in a range of Lancashire boilers 8 feet in diameter, at 11 feet, it works out that the Livet steam generator would evaporate 402 pounds (6.4 cubic feet) of water per foot width of frontage, and the Lancashire boiler 622 pounds (0.9 cubic feet). Converting this into power, at the rate of 20 pounds of water per independent horse power, it works out that the Livet steam generator would develop 20 independent horse power per foot width of frontage, and the Lancashier boiler 31 independent horse power, so that a Lancashire boiler develops 50 per cent. more power per given width of frontage than the Livet steam generator.

The M. S. U. A. would decidedly recommend the adoption of a Lancashire boiler, having a length of 30 feet, with a diameter of 8 feet 6 inches in the shell, and 3 feet 6 inches in the furnace tubes, for burning refuse fuel, in preference to a Livet steam generator.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car-Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

EVAPORATIVE TEST ON THREE STERLING BOILERS AT THE WALTHAM BLEACHING AND DYE WORKS. Waltham, Mass. *Dean & Main and D. P. Jones, Engineers.* Published by the Sterling Company, Chicago, Ill. 8 pages, 5¼ by 8½ inches. (Not standard size.)

In this test an evaporation of 13.03 lbs. of water per pound of coal is reported, which, of course is very good and accounts for its publication by the Sterling company.

COMPARATIVE TEST MADE BY THE PITTSBURGH TESTING LABORATORY, LIMITED, *for Carrie Furnace Company.* Pittsburgh, Pa. This report is issued by Messrs. H. E. Collins & Co., of Pittsburgh, who apparently are the agents or manufacturers of the Cahall water-tube boiler. The test, of course, showed to the advantage of the Cahall boiler, otherwise, it would not have been published by this firm.

SCHOEN PRESSED STEEL COMPANY, Pittsburgh, Pa. 16 pages, 7¼ by 10½. (Not standard size.)

The purpose of this publication is to describe the Schoen Pressed Steel Truck Frame, which is a specialty of manufacture by this company. It is illustrated by outline and perspective veiws which show all the details of construction very clearly. This truck frame belongs to the class which are made of plate steel flanged and formed into the required shapes, and which are now being very extensively introduced.

AN ILLUSTRATED DESCRIPTION OF A NEW DRIVER KNOWN AS THE LIDGERWOOD RAPID UNLOADER, USED FOR UNLOADING DIRT, BALLAST, ETC., FROM FLAT CARS IN RAILROAD WORKS. *Lidgerwood Manufacturing Company.* New York. 32 pages, 5¼ by 9 inches. (Not standard size.)

The title of this pamphlet indicates its character. In it the arrangement for unloading cars is illustrated with a number of half-tone engravings and its construction and operation is described quite fully.

LIDGERWOOD CABLEWAYS, HOISTING AND CONVEYING DEVICES. *Lidgerwood Manufacturing Company.* New York, 110 pages, 5¼ by 9 inches.

This is quite an elaborate treatise on the class of machinery which it is intended to describe. With many illustrations and descriptions of the various appliances and their details which are in use. Some illustrations made from photographs of machinery used in the Chicago Drainage Canal are very interesting and give an idea of the magnitude of that great work.

THE JEFFREY LABOR SAVING APPLIANCES. *The Jeffrey Manufacturing Company.* Columbus, Ohio. 5¼ by 8 inches. 60 pp., (Not standard size.)

The safety appliances referred to in this title are: Chain Belting, Elevators, Conveyors, Carriers, Steel Cable Conveyors, Power Transmission Machinery, Mill, Factory and Mine Supplies and Mining Machinery. Many illustrations of such "plants" are given in the book must of which are half-tone engravings made from photograph, although some of the details are shown by wood engravings. The whole "get-up" is very neat and effective.

INTRODUCING THE STRATT N COMBINED SEPARATOR AND STEAM RECEIVER. *The Goubert Manufacturing Company, New York.* 8 pp. 6 by 9 inches. (Standard s ze.)

The first word of the title of this pamphlet indicates that it was published for some special purpose, and not as a complete description of the device to which it refers. It opens with an excellent description of what the Stratton Separator is, and then describes the fall of pressure which occurs between the boiler and the engine, and how it is obviated by placing a receiver between them. The purpose of the pamphlet apparently is to show how the appliance described serves the purpose of both a separator of moisture from the steam and a receiver. For a description of the device the reader is referred to a treatise on "Dry Steam the Foundation of Economy," which has been issued by the company.

The illustrations, printing and paper are all excellent.

THE "THORNYCROFT" WATER-TUBE BOILERS. *Messrs. John Platt & Co., Agents.* New York. 8 pages, 7¼ by 9¼ inches.

Messrs. Platt are the agents in this country for the Thornycraft boiler, which is better known in Europe than it is here. There it has been applied to a great many ships ; more than 200,000 horse power are said to be in use. In the pamphlet its advantages are set forth very concisely, and illustrations are given showing the different types and describing their uses.

Another four-page pamphlet of nearly the same size is sent with the first one, in which the Thornycroft automatic field regulator is illustrated and explained. This is an important adjunct to water-tube boilers, and seems to be essential to their satisfactory working.

CATALOGUE OF THE CLEVELAND TWIST DRILL COMPANY, *Manufacturers of Increase Twist Drills, Self-Feeding Reamers, Taps, Cutters, etc.* 1896. 62 pages, 6 by 9 inches. (Standard size.)

As the name of this company indicates, one of its leading productions is twist drills, and these are found in every conceivable style in this catalogue. The list includes those with straight, taper and square shanks, drills with straight and with spiral flutes, drills with oil-feeding ducts or tubes, drills for machinists' and blacksmiths' drill presses, wood bitts for braces and for machines, drills in English measurements and in millimeter sizes, and for many special requirements. The company's grip socket, which embodies a great improvement in the method of driving taper shank drills and other tools, is also illustrated. Boring bars, drill holders, steel sockets for drills, center reamers, nut taps, staybolts and other boiler taps, arbors and mandrels, shell reamers, self-feeding and expansion reamers, chucking and taper reamers of all kinds, end mills and milling cutters, are among the many useful tools illustrated in this catalogue. The company also make twist drill grinding machines of various sizes. Of the goods mentioned many sizes are carried, and the company is also ready to consider the construction of special tools, correspondence concerning which is solicited. The catalogue is very neat in appearance. A copy of it will be sent to any of our readers upon written application to the Cleveland Twist Drill Company, Cleveland, O.

FERRACUTE MACHINE COMPANY. Presses and Dies, Bridgeton, N. J. 32 pages 7 by 10 inches. (Not standard size.)

This catalogue has the peculiarity that all the leaves in it are twice the size of the cover and are folded inside of it, which seems to

be an excellent plan where it is desirable to get a large page and yet keep the size of the book within reasonable limits. The company makes foot and power presses, lathes, beaders, dies, etc., for working various kinds of bar and sheet metals, which are very fully illustrated in the catalogue before us.

DESCRIPTIVE CATALOGUE OF THE INSTITUTE FOR HOME STUDY OF ENGINEERING AND OF ELECTRICAL APPARATUS FOR ITS STUDENTS. *The Scientific Machinist Company, Cleveland, O.* 48 pages, 6¼ by 10 inches. (Not standard size.)

Competition has invaded the educational institutions as well as other industrial fields. There are now several rival "Home Study" institutions to enable students who cannot attend a school to pursue a course of study at home, and who can be helped in so doing by correspondence with a school which has a staff of instructors. The publication before us gives a description of the methods employed by the Cleveland school, which has been organized as a sort of annex to *The Scientific Machinist*, a paper published in that city. Doubtless many young men who are unable to have any other technical educational advantages may derive much advantage from the system of correspondence which has been organized in this and other schools.

THE ASHTON VALVE COMPANY. Boston. 80 pages. 6 by 9 inches. (Standard size.)

This company manufactures safety valves, steam gages and other kindred appliances and has just issued a new and handsome catalogue. Its frontispiece is a view from a photograph of the works of the company in Boston. Following this is an excellent portrait of the late Mr. Ashton, the founder of the company, whose well-known face was missed at the railroad convention this year, as he had been a constant attendant at these meetings for a great many years.

The illustrations of the articles manufactured by the company are excellent wood engravings and the typography, paper and press work are in excellent taste. The products of the company include the Ashton lock-up pop safety valves for different classes of boilers, water relief valves, shifting relief valves, car-heater valves, mufflers for safety valves, blow-back pop safety valves for locomotives, steam gages and pressure gages for a variety of purposes. Besides these articles the company makes a variety articles which are collaterally related to the principal departments of its business. The publication ends with a good index, which must be commended.

CATALOGUE AND PRICE LIST OF THE ARMSTRONG MANUFACTURING COMPANY, BRIDGEPORT, CONN.; *Water, Gas and Steam-fitters' Tools and Machines for Cutting Off and Threading Pipe.* 1896. 50 pages, 5 inches by 6¾ inches. (Not standard size.)

This catalogue contains descriptions and prices of the well-known Armstrong pipe stocks and adjustable dies in various sizes. The largest of these will thread 4-inch iron pipe. They also make stocks and dies for bolts and for brass pipe. A new feature of this latest catalogue is the pipe threading and cutting-off machines, of which the smaller sizes are made for either hand or power. All the driving gears are enclosed in an oil chamber, which keeps out dirt and chips and insures good lubrication. The largest size will cut off and thread pipe from 1 inch to 6 inches in diameter. The company also makes a full line of vises, including combination, plain and hinged vises, and vise jaws for brass pipes. They also make Armstrong pipe cutters, pipe wrenches, taps and tap wrenches, lathe dogs, machinists' and carriage makers' clamps and many other useful tools. The New York office of the company is at 139 Centre street.

THE STOW MANUFACTURING COMPANY, *Inventors and Manufacturers of the Stow Flexible Shaft.* Binghamton, N. Y. 40 pages. 6 by 9 inches. (Standard size.)

The Stow flexible shaft is so well known that it is not necessary to give any description of it, but this catalogue contains many interesting pages, illustrating the various uses to which it can be put, and the company manufactures the attachments needed for special work. So general has the use of flexible shafts become that the company has demands for them from nearly all trades and lines of work, including bicycle builders, instrument makers, door and blind manufacturers, surgeons, dentists, etc., etc. To meet special requirements they have been made to run at speed as high as 17,500 revolutions, and there is now quite a demand for waterproof shafts, which the company has successfully met. Among the many neat devices manufactured by the concern for use with these shafts might be mentioned breast drills, portable drills, pedestal drills, track and "corner" drill presses, tapping and reaming machines, universal joints, countershafts and pulleys for rope drives, portable emery grinders, clutches, spindles, ring grinder, and drill and reamer sockets. They also turn out portable electric motors, fitted with flexible shafts, and their radial flexible drilling machines, which consist of a radial belt drive for the shaft, attached to the ceiling or any suitable overhead structure, will drill a 2-inch hole anywhere within a 21-foot circle without occupying any floor space when not in use.

The company is ready to give its patrons the benefit of its experience in special work and invites consultation where parties have an idea that their wants can be met by any special adaptation of the flexible shaft or its fittings. The catalogue itself is very instructive in this respect and will repay a careful perusal.

DESCRIPTION, METHOD OF OPERATION AND MAINTENANCE OF THE VAUCLAIN SYSTEM OF COMPOUND LOCOMOTIVES. The Baldwin Locomotive Works; Burnham, Williams & Company, Philadelphia; 79 pages; 6 by 9 inches. (Standard size.)

This is a new edition of a pamphlet issued for a similar purpose some years ago, but which has been entirely rewritten, and containing many new engravings of locomotives not heretofore published. It opens with a statement of the aim of the inventor in designing the system of locomotives described therein. The principal features of the compound construction are then described, with an explanation of the action of the steam in the cylinders. To make this clear engravings are given of the cylinders, steam chest, bushings, pistons, valves, diagrams of the valve-gear, valve-stem guide, crosshead, piston, starting-valve and its arrangement. The operation of the engine and the method of running it are next described, and its various advantages are set forth. An interesting diagram is given showing the water consumption of simple and compound locomotives at various points of cut-off. A separate division is devoted to the methods of making repairs of these parts of this type of locomotives, which differ from simple engines. The methods of reboring, renewing and removing the bushings of the steam-chests for the piston-valves—which are used on these engines—is described with illustrations of the apparatus employed and its application to the engines.

In the form of addenda an explanation is given of how fuel economy is effected and the water consumption calculated, and also how the indicator diagrams from the cylinders can be combined to show the action of the steam in the cylinders to best advantage. A list shows that up to date 615 locomotives of this system have been built or ordered of the Baldwin Locomotive Works, which is probably a larger number of compound locomotives than have ever been built by any other establishment in the world. The volume concludes with brief reports of various tests which have been made on different roads with compound and simple locomotives.

Besides the text and various illustrations of details there are 95 engravings of different classes of locomotives illustrated by half-tone engravings made from photographs. These illustrations are of varying degrees of excellence, some being very good and others not so good. Almost all classes of locomotives used in this country and some for foreign lands are included in these illustrations. Among them are tramway motors, locomotives for suburban traffic, for rack mountain roads, single wheel, American and Columbian passenger locomotives, moguls, ten-wheelers, consolidation and decapod engines—all of the Vauclain four-cylinder compound construction.

The letterpress is printed in brown ink, but the engravings are black. The paper and topography are excellent, and the volume is bound in a drab-colored paper cover; it may be presumed to indicate its Quaker origin.

MANUAL OF THE SELF-ACTING INJECTOR OF 1887. Wm. Sellers & Co., Incorporated. Philadelphia; 24 pages 6 by 9 inches. (Standard size.)

The title of this catalogue indicates its general character. It illustrates, describes and sets forth the advantages of the form of injector which was brought out by this company in

1887. The illustrations are excellent wood engravings, representing sections and outside views of the different patterns which are made. The opening page gives a "Brief History of the Injector," which is so concise that there is room to quote it entire.

"The injector," it is said, "was invented by Giffard in 1850, and patented by him in France eight years later. In 1860 it was introduced in this country by William Sellers & Co., and the manufacture of it commenced at their works in Philadelphia. The early form of the injector was provided with adjustments for both the water and the steam, and the fact that many of these instruments are still in use attests the advantages of this arrangement. The necessity of frequent adjustment of the water ram led to the invention of the movable combining tube, which automatically regulated the water supply to suit all changes in the pressure of the steam. From this form was developed the Sellers self-adjusting injector of 1876. To simplify the operation of starting and to render the action of the jet positive under the most adverse conditions, automatic starting and a new system of automatic adjustment of the water supply were combined in an injector in which all the nozzles were fixed, the self-acting injector of 1887."

This latter is the instrument described in the catalogue which is before us, the opening page of which gives a statement of "convincing reasons why the self-acting injector of 1887 is better adapted to economical high-pressure locomotive service than any other injector." These "reasons" are followed by a description of its construction and operation. A table of sizes, capacities and prices follows this, after which there is a list of names of parts which are designated by numbers in a sectional view. The following pages give "hints" when the injector will not lift and when it will lift but will not deliver the water into the boiler, and miscellaneous suggestions with reference to the operation and repair of the injectors. In the last part the angle and check valves, which are used with these instruments, are illustrated and described. All the engravings are excellent and are made on wood, and are specimens of the art by which machining may be represented more satisfactorily than by any other now known, notwithstanding all the inventions made in that direction during the last quarter of a century.

ROBINSON RADIAL TRUCK. The Robinson Electric Truck and Supply Company, Boston. 20 pages, 7 by 9¼ inches. (Not standard size).

The Robinson Radial Truck, it is said, in the introductory chapter before us, "consists essentially of three flexibly connected single steel axle-frames, each containing one pair of wheels. The end frames are pivotally connected to the car body, while the intermediate frame travels between guides, transversely across the car-body, thereby causing the axles to become radial on curves and parallel on straight lines." This truck belongs to that class in which the frames which carry the end axles are connected to the car body by center pins, about which they can turn. The middle axle—there are three—is attached to the body so that it can move transversely to it. The frames of the end axles are also connected to the middle one in such a way that any transverse movement of the latter will turn the former about their center pins. By this means the three axles are made to assume a position radial to curves.

The pamphlet before us is well illustrated with outline drawings, showing the construction and arrangement of the trucks, and also with half-tone engravings made from photographs of cars with these trucks which have been supplied to various roads in the country.

An appropriation of $30,000 has been made by the Pennsylvania Railroad Company for a Young Men's Christian Association building at Wall, Pa.

It is reported that American railway corporations contribute $130,000 annually to the work of local Railroad Young Men's Christian Associations along their lines. Forty-six buildings, whose value is $560,000, are owned or held by the Railroad Associations for this use.

MASTER CAR BUILDERS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Thirtieth Annual Convention.

(*Continued from page 164.*)

Passenger Car Ends and Platforms.

Committee: E. W. GRIEVES, C. A. SCHROYER, T. A. BISSELL, F. D. ADAMS, M. M. MARTIN, J. J. HENNESSEY, S. PORCHER.

Your committee submits to the Association a drawing of a construction that it considers a combination of the best practices now in use, with some additional improvements in same, for your consideration; but your committee, after careful investigation, has every reason to believe that this construction infringes patents now in use; therefore, it is not in position to recommend that it be adopted as a recommended practice of this Association.

The drawing shows the side sills reinforced ⅛ by 7-inch iron plates placed between the side sill and a 2-inch sub sill, and the same thickness of plate placed between the center sill and the 2½-inch sub sill, each extending back to the tie timber and bolted together in the same manner. The end sill is made 8 by 8 inches, with ¾ by 3½ by 7-inch angle iron placed between the wood and bolted together.

The corners at end and side sills are secured together with ¾ by 7-inch wrought-iron corner bands and ¾-inch bolts. The center sill plate is flanged against end sill and secured in same manner. The end wall framing is reinforced by ⅛ by 2 by 3¼-inch angle irons, which are flanged to end sill and end plate, and part of the angle iron extending down, connecting the angle irons on the posts to the same on end sill and end plate, making a continuous iron frame on end of car. The vertical tie rods are used in the usual manner to secure the end plate to end sill.

The committee would call attention to the fact that this construction makes a solid iron frame for one end of car, each piece being secured to the other, forming one continuous iron frame. The platform and arrangement of buffer plates, springs, etc., are familiar constructions and are a combination of different platforms now in use, the main feature being that the retaining springs are for the purpose of keeping the buffer and springs in position when not in contact with another car, and the use of the combination malleable iron crosshead guide and buffer spring casting, which abuts against the end sill. Another feature of this platform is the arrangement of draft springs, and the use of cast steel follower carry iron and double pockets, which, in connection with the followers, tail pins and spring pockets, allows the use of two draft springs, thus doubling the capacity of springs without increasing the deflection. The coupler stirrup is also somewhat improved in that it has a very large opening for coupler, which allows sufficient movement to overcome any transverse strains on the platform timbers, the coupler being held in alignment by side springs. The coupler stirrups have enlarged ends and are secured to end sill with two 1-inch rods. The draft timbers and platform timbers are plated with ⅛-inch iron, which extends the full length of timbers.

The impact required to make a coupling between two cars is exerted only on a small center and two side buffer springs which are calculated to have a capacity of 13,700 pounds, while any other compression after the cars are coupled will go to the buffer springs, having a total capacity of 25,700 pounds. Any compression, when the cars are coupled, would also go on the draft springs through the coupler, and the draft springs would have a capacity of 32,400 pounds, and this, combined with the buffer springs, gives the total buffing spring capacity of 58,100 pounds. The working load of this spring, however, is only about one-half of these figures, or 29,050 pounds. The push-bar is attached to the coupler at the tail pin connecting with cross-head at back of center buffing springs, thus transmitting the draft strains to the buffer springs, keeping the bufters always in contact when cars are coupled together.

Location of Air-Brake Cylinders on Freight Cars.

JAS. MACBETH, ROBT. GUNN, H. C. MCCARTY, B. HASKELL, F. B. GRIFFITH, A. C. ROBSON, JOEL WEST, Committee.

Your committee finds, on the basis of 1,210,000 freight cars in service at the present time, which is taken from recent reports of the Interstate Commerce Commission, that approximately one-third of this number are now equipped with air-brakes. Experience has demonstrated, at various inspection points, that 55 per cent. of the freight equipment interchanged is equipped with air-brakes at the present time, owing to the fact that a large percentage of cars not equipped with air-brakes do not leave the line of some companies owning the same. This clearly emphasizes the volume of work for the proper maintenance of the brake, and also the additional duties to the inspecting and repairing force. It is therefore apparent that the air-brake cylinders and triple valves should be located in such a position that the attention they require can be readily and safely given, causing the least possible delay to traffic, and result in maintaining the brakes in the most efficient manner. The committee would therefore make the following recommendations:

Air-brake cylinders and reservoirs should be placed on cars on a line inside of stake pocket as near center of car as possible. A clearance of at least 12 inches should be allowed for the removal of cylinder head. Special attention is called to this point, as a number of railroads are now locating cylinder in a position which brings cylinder head within four or five inches from needle beams or other parts of car, preventing, without great difficulty, the removal of head.

The main pipe should be located as near the outside line of side sill as possible. This will enable the men to readily reach and

clean the drain cups in main air pipe, and will also place the pipe in a position on gondola cars, where the least possible injury will be caused by the dripping of water on pipe after having passed through bituminous coal that cars may be loaded with.

The cut-out cock should be located under the car near the center, where it can be reached from either side, and be subject to the least interference by irresponsible parties, which already has developed.

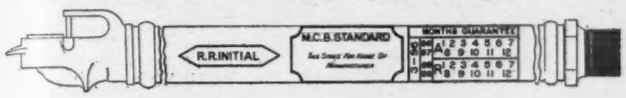
The air brake branch pipe should be connected to top of drain cup in main pipe instead of bottom, in order to avoid, as far as possible, the tendency of dust and dirt to pass through strainer to triple valve.

The release valve should be placed on top of reservoir and handle extended to each side of car.

When necessary to provide holes in needle beam or other parts of car to accommodate rods or levers, the committee recommends that they be made sufficiently large to allow ample space for the operation of rods or levers, as it has already been found that openings provided have been so small as to prevent rods from moving.

Rods should be parallel with line of car, as far as practicable, and properly supported with hangers, to avoid binding and breaking of piston sleeves.

The committee received, after its appointment, a communication from the secretary, stating that it was the desire of the president that it also take up the question of, and incorporate in its report, a method of marking hose, so that the lifetime and service of hose could be more carefully and intelligently followed up.



Proposed Marking of Air Brake Hose.

It is known that some of the leading manufacturers are now marking the hose they manufacture. Their plans were considered, together with additional points that the committee considered essential, in order that the highest uniform degree of efficiency may be reached in hose, and would therefore recommend the marking as shown on accompanying cut.

The number of months' guarantee was omitted, as in the opinion of the committee this is a question between the railroad purchasing and the manufacturer, and by requiring that all hose be plainly marked with the initial of the road purchasing and manufacturer's trade-mark or name, and also a time guarantee; the character and service of the hose can be readily followed up, and such hose, with a very limited time guarantee, will soon develop to the purchaser and manufacturer its inferiority or superiority compared with other hose.

Size of letters and figures to be not less than one-quarter of an inch.

Stenciling of Cars.

A. M. WAITT, S. HIGGINS, H. S. HAYWARD, Committee.

Your committee, to whom was referred the communication from the Car Inspectors' Association of North America, recommending for the facilitating of work of inspection that all car owners be requested to stencil height and width of all high cars on the side of the car, and also that car owners be required to stencil size of journal on truck planks; also the numbers and initials of all box cars on floor timbers between cross-tie timbers, begs to report as follows:

Communication with the Secretary of the Car Inspectors' Association develops that the reasons for requesting the adoption of their recommendations are:

First. To expedite the movement of freight, especially at night, when it is difficult to read the car numbers and initials where they are located high up on car side.

Second. To save loss of time in having to measure unusually large cars in order to know whether they will properly clear bridges, tunnels, etc., on the receiving company's lines.

Third. To facilitate movements of inspectors in ascertaining proper size of journal bearings or axles in connection with repairs.

Your committee wishes to commend the spirit of interest in the improvement of the service shown by the action of the Car Inspectors' Association, and we believe the suggestions made are good ones and worthy of having the general approval of the M. C. B. Association.

There are some difficulties in the way of carrying out literally the proposed stenciling on account of the different contour lines of high cars, and from the fact that some special classes of cars are sheathed over underneath, covering in the sills and floor timbers.

We believe, on the other hand, that the recommendations of the Car Inspectors' Association do not go quite far enough in attaining the desired smoothness in handling inspection work at interchange points. Oftentimes it is impossible for inspectors to tell, in connection with some of the prominent and expensive features of the cars, what is the proper standard. It would seem, to your committee, desirable to a limited extent to cover these points by proper stenciling. Your committee would, therefore, recommend:

First. That on all box cars standing more than twelve (12) feet from top of rail to eaves, the width at eaves be stenciled in 3-inch letters on side of car, as near the bottom as convenient.

Second. That all box, stock and other roofed cars have the number and initials stenciled in 3-inch letters on outer face of outer floor timber between cross-tie timbers, except where cars are ceiled over underneath, in which case the stenciling shall be put on inside face of each cross-tie timber in center.

Third. That all classes of cars have style of coupler and rear attachments, and style of brake-beams stenciled in not less than 1½-inch letters near one end of car on each side, or on each end of car directly above the buffer blocks where design of car permits it.

Fourth. That where the construction of the truck permits trucks shall be stenciled on each side, giving the size of journal, and the letters "M. C. B." if the axle is M. C. B. standard axle. If the axle is not M. C. B. standard use dimensions from center to center of journal in place of M. C. B. This stenciling to be in 1¼-inch letters and to be put on end or side of bolster in Diamond trucks, and on side-truck frame in center on Fox trucks.

Fifth. That on all cars equipped with air-brakes the words "Air Brake," in letters not less than 3 inches high, be stenciled on the sides or ends of the cars, and that the make of air-brake equipment be stenciled (in smaller lettors if desired) over or just preceding these words, to enable inspectors to detect repairs made with wrong material. Respectfully submitted,

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

Abstracts and Summaries of Reports Presented at the Twenty-Ninth Annual Convention.

(*Continued from page 157.*)

Reciprocating Parts.

Committee, H. D. Gordon, C. F. Thomas, C. G. Turner, T. A. Lawes, J. A. Hill.

The committee making this report assumes that the necessity for keeping down the weight of reciprocating parts is appreciated, and it proceeds at once to discuss various designs for such parts. Under the head of pistons a number of designs are illustrated as follows: London & North Western Railway, single plate cast steel piston, 30 inches diameter, weight 288 pounds; an 18 inch piston, weight 139 pounds; Richmond Locomotive Works, single plate steel piston, 31 inches diameter, weighing 387½ pounds, and complete with rod 535 pounds; a similar 20-inch piston complete with rod 358 pounds; Pennsylvania R. R. single plate steel pistons, one 20 inches diameter, weighing 221 pounds, and one 29 inches diameter, weighing 395 pounds; a steel box piston with castiron bull-ring, built by the Schenectady Locomotive Works, of which one 19 inches in diameter complete with rod, weighs 318 pounds; also a Schenectady single plate cast steel piston of the same size weighing complete with rod, 299 pounds; and the malleable iron piston of the Norfolk & Western Railroad, illustrated in our June issue. In the way of piston rods the report illustrates a hollow rod, 3½ inches, outside diameter, with a 1¾-inch hole through it from the front end back to the crosshead fit, which design one member of the association intends to try. Various types of crossheads are illustrated, for four-bar, Laird, and other two-bar guides, some of them reduced to the smallest possible weight consistent with strength. The detailed weight for reciprocating parts for standard engines on the London & Northwestern Railroad, the Northeastern Railway of England, Lancashire & Yorkshire, and Caledonian Railway of Scotland, conclude the report.

Steam-Pipe Joints.

GEORGE GIBBS, E. A. WILLIAMS, JOHN HICKEY, J. J. ELLIS, JOHN SMITH, Committee.

As far as the committee has been able to learn it appears to be the uniform modern practice to use cast iron for both steam and exhaust pipes, and this practice appears to give satisfactory results.

Two roads report having made experiments lately with wrought and malleable iron for steam-pipe material. The results are said to be satisfactory, except in the matter of first cost. These pipes are made as thin as consistent with strength and it is claimed they spring so readily that strains on joint-bolts are much relieved and frequency of leaky joints thus lessened.

All but one member state that some form of brass rings are used for top and bottom steam-pipe joints. These rings are sometimes double convex, in others concavo-convex, but most generally plano-convex.

Two members have tried cast-iron joint rings, but condemn them on account of corrosion and the brittleness of the metal, which makes them more difficult to handle. Another member, however, representing a large railway system, prefers cast-iron rings; states they give less trouble than brass, which latter he is replacing as rapidly as possible.

For exhaust-pipe joints, the general custom is to make them with flat surfaces, cast iron to cast iron, scraped to a fit.

Steam-pipe joints are usually secured by two bolts or studs top and bottom, which pass through cast flanges on the pipes, tee-head and saddle. Many of the members who replied to the committee consider this form of joint satisfactory. But others, the majority of whom are using heavy engines in severe service and with high steam pressures, report increasing trouble with loose joints. Their opinion seems to be that more bolts should be used, preferably four top and bottom. The few results obtainable with these reinforced joints seem to indicate that it is the proper solution of the difficulty.

In summing up the information furnished by members, your committee can find little well-grounded complaint with present form of pipe joints in locomotive front ends. And practice is so uniform, even as to details, as to indicate a substantial accord throughout the country in ideas of a satisfactory arrangement. It is quite easy to get the impression, from the ordinary attention to roundhouses which a master mechanic is able to give, that regrinding joints constitutes the chief item of roundhouse repairs, while in reality such work may not be more than would ordinarily be expected from results of service wear and tear.

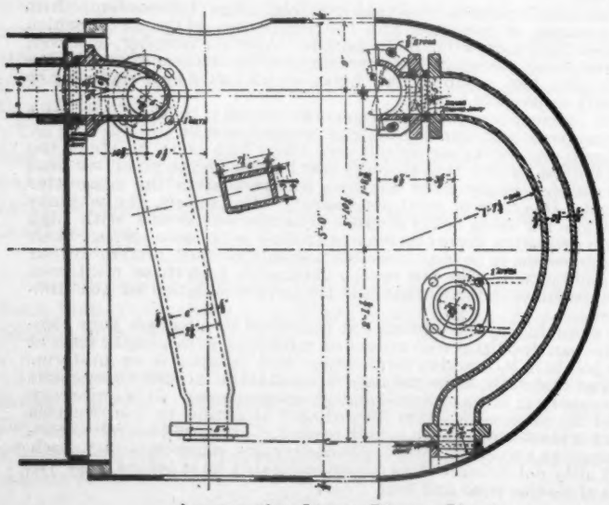
Exhibit of Root's Improved Steam Boiler at the National Electrical Exposition.

It is true that repairing joints is an annoying and lengthy operation with the modern extension front locomotive, laying up the engine for about three days' time, and taking up valuable roundhouse room. The cost of regrinding steam-pipe joints on both ends, at a large division point, may be taken as follows:

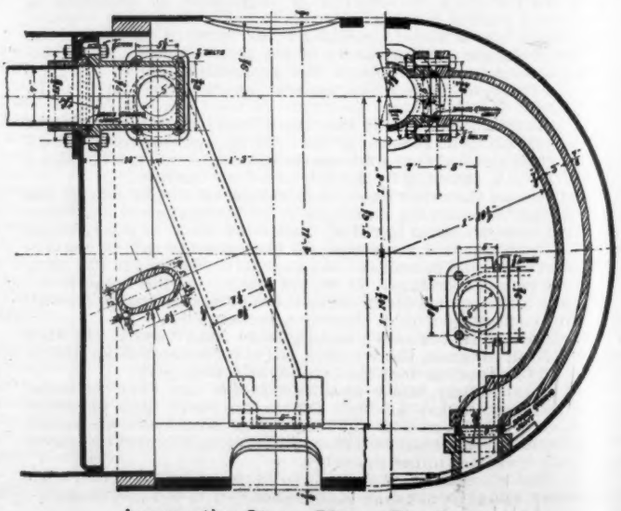
Removing and replacing	front end	4 hours
" " "	steam pipes	6 hours
" " "	netting	4 hours
" " "	plates	3 hours
Grinding joints		10 hours

On all above operations two men are employed, making 54 hours of labor. At rates usually paid machinists, boilermakers and helpers, the total cost of the operation is about $10.

In this same large roundhouse, in which 150 engines are turned per day, it was found that between three and four engines per month have pipes reground. Of these, about 40 per cent. had either loose cylinder saddles or had been out of shops after general repairs from two to three months only. In this latter case, the defect was probably caused by some imperfect shop work; and in the former, joints could not be expected to remain tight; in fact, the testimony



Locomotive Steam Pipes.—Fig. 1.



Locomotive Steam Pipes.—Fig. 2.

of members leads to the conclusion that trouble with joints is quite infrequent except on account of bad workmanship, loose saddles or insecure bolting in high-pressure heavily worked engines.

The suggestions for improvement made by members follow from the above, and are, briefly, that saddle fastenings be kept tight, and that more bolts be used to hold the pipe flanges together beyond a possibility of their working under the strains caused by expansion.

Your committee would, therefore, offer conclusions in line with the above given evidence, and make the following recommendations for approved practice:

Steam pipes should be of cast iron of flattened section, as light in the body as consistent with strength and the requirements of foundry practice. The shape of the pipes and general arrangement of the joints should be as shown in Figs. 1 and 2.

Your committee suggest, as worthy of trial, pipes of malleable iron or cast steel. Such pipes may be quite thin and still have ample strength, with the resulting advantage of springing instead of working at the joints when expansion strains are brought upon them.

The flanges should be arranged, where possible, to take four bolts or studs at both ends on all heavy engines. These bolts should be equally spaced, if possible. The joints should, in all cases, be made up with plano-convex brass joint-rings, the radii of their convex faces to be about equal to the inside diameters of the rings. These rings should be carefully ground upon their corresponding joint surfaces.

The exhaust-pipe joints should be made with flat surfaces, carefully scraped and fitted with surface plate, and bolted together without copper or other gaskets. A small amount of red lead, or some kind of heat-hardening cement, may be used if preferred.

Figs. 1 and 2 are submitted as representing good practice in the make-up of heavy joints.

Exhibit of the Root Improved Steam Boiler at the National Electrical Exposition.

Our illustration gives a very good view of the exhibit made by Messrs. Abendroth & Root Manufacturing Company, 28 Cliff street, New York, of their well-known improved Root water tube boiler at the recent National Electrical Exposition, New York City.

These boilers were selected by a special committee to furnish all the steam used at the Exposition, the desire being to install a thoroughly reliable and model up-to-date boiler plant.

This was the only working boiler plant shown and attracted much attention and favorable comment from visitors, who could not but be impressed with its cleanliness, efficiency and the ease with which it was managed. There were two equal units, forming one battery of 500 horse-power. A Wilkinson automatic stoker was used to distribute the coal upon the fire.

The evaporative efficiency ranged from 10 to 11 pounds of water to a pound of coal. The C. W. Hunt noiseless conveyor was used in delivering the coal and taking away the ashes.

So safe and simple was the entire operation of this plant that it was put in charge of Mrs. Frank Walton, a licensed woman engineer, who, as chief engineer, managed the exhibit with skill and judgment.

The battery of improved Root boilers used at the National Electrical Exposition was an exact duplicate of the six batteries of Root boilers used at the celebrated tunnel plant of the Baltimore & Ohio Railroad in Baltimore, Md.

Henry F. Hill, 123 Oliver street, Boston, Mass., has been appointed New England agent for the Ingersoll Milling Machine Company.

The Cincinnati, Hamilton & Dayton road is making preparations at its Lima shops for the equipment of all its cars with automatic car couplers.

The Nordberg Manufacturing Company, of Milwaukee, manufacturers of engines, are increasing the capacity of their works, the Niles Tool Company, of Hamilton, O., supplying the new machinery.

Since the Saratoga conventions the Sams coupler has been ordered by seven Eastern railroads, and is being put into service by many companies on special equipment cars and on cars that do not go into interchange traffic.

The contract for the building of the Butler & Pittsburgh Railroad was let last month. There were 47 different bids representing 100 firms all over the country. The contract was given to C. I. McDonald & Company, of Pittsburgh.

The Sargent Company, of Chicago, have made a contract to handle the "Compo" brake shoe in the West. This shoe is a composition of cast-steel and compressed wood, and is meeting with great favor on electric and elevated railroads.

Mr. Otto Goetze, 114 Broad street, New York, has issued a little pamphlet descriptive of "Mannocitin," and containing the opinions of some leading American firms regarding it. Mannocitin is a rust-preventive which those who have given it a trial find to be most excellent. Any one wishing to obtain a copy of the pamphlet can do so by applying to Mr. Goetze.

The Q & C Company, Chicago, has recently made a valuable addition to its Perfection Oil Purifier, illustrated in our April number. This is a thermostatic temperature regulator, which automatically holds the temperature at a degree which facilitates the filtration of the oil without overheating. Several of these are in operation with very satisfactory results.

The firm of Wilson & McIlwain, manufacturers' agents, at Pittsburgh, has been dissolved by the withdrawal of John T. Wilson, whose other business interests made it impossible to devote the necessary time to the firm's affairs. Mr. McIlwain has associated with him his son, Harry M., and will continue the business under the firm name of J. D. McIlwain & Company.

The Brown Hoisting & Conveying Machine Company, Cleveland, O., have sold to E. D. Smith & Company two standard 10-ton locomotive cranes to be used on the work of extending the wheel pits of the Niagara Falls Power Company, to accommodate seven more 5,000 horse-power turbines. These cranes are fitted with extra large drums to take the great length of rope that will be required in hoisting out of the wheel pits.

To the New York Steam Company's Cortlandt street plant has recently been added a 1,000 horse-power boiler weighing 119,000 pounds, or 59½ tons. The boiler was built by the Edgar Boiler Company, Limited, of Warren, Pa. It is of the vertical tubular cylindrical type, 23 feet long and 10 feet in diameter, with 220 tubes 5 inches in diameter. The shell is of ¾-inch steel. A 7-inch circulating tube surrounds each tube from the water line to near the bottom head.

The Ingersoll-Sergeant Drill Company have received an order from the Pennsylvania lines for four half-duplex air-compressors of the class "G" pattern, with Myer valve gear. The steam cylinders are 10 inches in diameter; air-cylinders 10¼ inches in diameter; stroke 12 inches. These compressors will be located as follows: One at Columbus, O.; one at Denison, O.; one at Indianapolis, Ind., and one on the Vandalia road at Terre Haute. The Big Four has also ordered a similar compressor for its Brightwood shops.

During the month of June Mr. Henry L. Leach, 176 Huron avenue, North Cambridge, Mass., shipped 170 sets of his pneumatic sanding apparatus, 119 of these going to the various locomotive builders for new equipment, as follows: To Baldwins, 25 for Lehigh Valley; to Pittsburgh, 22 for Vandalia and 12 for Seaboard Air Line; to Schenectady, 5 for Southern Pacific, 10 for New York, New Haven & Hartford and 2 for Fitchburg; to Cookes, 5 for Southern Pacific and 10 for Baltimore & Ohio; to Richmond, 25 for Baltimore & Ohio; to Brooks, 3 for Burlington, Cedar Rapids & Northern. Among the shipments for old equipment were 30 for the Norfolk & Western and 12 for Southern Railway.

The Carnegie Steel Company, Limited, nearly two years ago, after making an investigation of the merits of the Cahall vertical water tube boiler, put in a trial plant of these boilers of 2,000 horse-power at their gas pumping plant, at Bagdad, Pa. The performance of the boilers was such a marked improvement over the general boiler practice of to-day that four of these boilers were afterward put in at their Edgar Thomson Steel Works. They have been so well satisfied with the work done by these that they have made arrangements to tear out all the old style boilers at furnaces A, B and C at the Edgar Thomson Steel Works and have purchased 5,250 horse power of the Cahall vertical water tube boilers, to be installed in place of the ones to be removed.

The facilities of the Roberts Safety Water Tube Boiler Company have been so greatly enlarged that they have just completed a 150 horse-power Roberts boiler for the steam yacht Sultana, on an order from the Erie Basin Dry Dock Company, in eight working days from the time they received the order. This boiler is built in the company's best style, the material has all been inspected, and the boiler will pass inspection for 250 pounds of steam. Two weeks' time was allowed by the contract, but the owner was very anxious to have his yacht in commission on July 4th, and the Roberts Boiler Company decided that they would beat the record on boiler building, and have undoubtedly done so. Notwithstanding the lateness of the season, they are running full time and have been working nights and Sundays lately.

The contract for the new bridge, to take the place of the rail road suspension bridge now spanning the Niagara River, has been

awarded to the Pennsylvania Steel Company, Steelton, Pa. The new bridge will have a span of 550 feet between piers, with short spans connecting the main span to the bluffs. It will have two floors, the upper one for two railroad tracks and the lower one for carriages, trolley cars and pedestrians. The piers will be of masonry built on the limestone about half-way up the sides of the bluff. The superstructure will require 2,780 tons of steel plates and angles, 109 tons of steel castings, 91 tons of steel I-beams and pins, and 15 tons of iron rods and turnbuckles. The bridge is designed for a load on the railroad floor of two consolidation engines, with 40,000 pounds on each pair of drivers, followed by a train of 3,500 pound per lineal foot, and at the same time the highway floor is to suppors a live load of 3,000 pounds per foot.

The Bates Thermic Engine Company, of Philadelphia, has been organized to build engines for furnishing power through the medium of gas. Russell Thayer is President of company, and Allan B. Rorke John F. Betz, Prof. W. D. Marks, Professor Houston, Professor Kennelly, Clement Newbold, D. S. P. Chew, Dr. Filbert. E. C. Quinn, Henry Clay, Jas. McManes, Jas. H. Harper, Clarence L. Harper and others are prominently connected with it. The engine to be built will produce power direct from fuel. It will require from 35 to 40 per cent. less space than ordinary engines, and save 25 per cent. in weight per effective horse power, which in steamers and torpedo boats is an immense advantage. The makers will gurantee a saving of 60 per cent. in the fuel necessitated by the use of the modern engine. Three of these engines are at present in operation in Europe, and five others are in course of construction. The fuel is burned under pressure in a small chamber near the engine cylinder and the gases of combustion used expansively in the cylinder.

The Hazelton Boiler Company, New York City, reports recent sales of boilers, aggregating 2,450 horse power, as follows: The Rochester Gas & Electric Company, Rochester, N. Y., 500 horse power; the Lambertville Rubber Company, Lambertville, N. J., 200 horse power; the Goodyear Rubber Company, Middletown, Conn., 150 horse power; the Bristol Electric Light & Railway Company, Bristol, Conn., 200 horse power; the Equitable Gas Light Company, New York, 500 horse power; the Pettebone-Cataract Paper Company, Niagara Falls, N. Y., 250 horse power; the North Adams Gas Light Company, North Adams, Mass., 150 horse power; the Canandaigua Electric Light & R. R. Company, Canandaigua, N. Y., 250 horse power, and the Newton Falls Paper Company, Newton Falls, N. Y., 250 horse power. They have also recently completed contracts with the Capewell Horse Nail Company, Hartford, Conn., and Messrs P. & F. Corbin, New Britain, Conn. The company reports that nearly all of their orders now being received are for the very earliest possible delivery, and that many of their recent sales have been made to old customers who are now enlarging their plants. The original boilers sold to these customers have been in constant operation for from eight to ten years, without repairs, still carrying high pressure, and giving the same fine results as when new. This, together with the fact that the Hazelton Company has made various improvements in the construction and setting of their boilers, increasing their efficiency and economy, and improving their appearance, makes it much easier for them to make sales now than formerly.

The Edward P. Allis Company, of Milwaukee, Wis., are at present very busy. Among the recent orders they have received may be mentioned two cross compound engines of 1,000 horse power each, direct-coupled to electric generators, for the Syracuse Street Railway Company, Syracuse, N. Y.; one engine of 800 horse power for the Brockton Street Railway, Brockton, Mass.; large hoist for Butte, Mont.; four large engines for the Otis Falls Pulp Company, Maine; a cross compound condensing engine for the McCormick Harvester Machine Company, Chicago, and a tandem compound engine for the Sandusky Electric Light Company, Sandusky, O. Their engine department has in hand the order recently received from the Northwestern Elevated Railway Company, of Chicago, for 9,000 horse power of engines, and they have just shipped a vertical compound condensing engine of 2,500 nominal horse power to the Warren Manufacturing Company, Warren, R. I. They have just started a twin tandem compound condensing engine of 2,500 horse power in the new Berkshire Cotton Manufacturing Company mill, Adams, Mass., and the first of the six large pumping engines which they are building for the city of Pittsburgh, in addition to which they have shipped the Canal & Claiborne Street Railway Company, New Orleans, two tandem compound condensing direct-coupled engines of 700 horse power each.

Their mining department has just received an order for the complete machinery of a large new reduction works to be built in Colorado. This order includes the engine, boilers, crushers, rolls, concentrators, chlorination barrels, etc., etc., in fact the entire machinery of the plant. The company's saw-mill department has had an order placed with them for the complete machinery of a mill in California which will be one of the largest saw-mills in the country. They supply in addition to the saw-mill machinery the necessary engines and boilers. There are now in operation six of the twelve vertical compound condensing blowing engines which the concern is building for the Carnegie Steel Company, and these machines in service more than exceed the expectations of all concerned. They are also about to ship a pumping engine to the city of Sacramento, Cal., and are beginning work on the large pumping engine recently ordered for Cleveland.

Our Directory

OF OFFICIAL CHANGES IN JULY.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Altamont & Manchester.—President C. C. Crooke died July 9.

Kansas City, Oklahoma & Southwestern.—Mr. K. H. Bates has been elected President.

Louisville, New Albany & Chicago.—Mr. B. E. Taylor has been appointed Purchasing Agent, vice J. H. Craig, resigned.

Buffalo, Attica & Arcade.—Mr. S. T. Dyke is acting Master Mechanic in charge of rolling stock and road bed.

Brainerd & Northern.—Mr. O. O. Winter is appointed General Manager.

Boston Terminal.—Mr. J. C. Sanborn has been elected General Manager.

Atlantic & Pacific.—Office of General Manager and Receiver removed to Great Northern Building, Chicago. W. H. Smith is appointed Purchasing Agent, with office at Albuquerque, N. Mex.

Rutland.—Mr. Geo. W. Kenney is appointed Superintendent of Motive Power, with office at Rutland, Vt.

Seaboard Air Line Belt.—Mr. R. C. Hoffman is chosen President to succeed Mr. J. H. Winder, resigned.

Chicago, St. Paul, Minneapolis & Omaha.—Mr. A. G. Wright has been appointed Division Master Mechanic at Altoona, Wis., to succeed Mr. W. E. Amann, resigned. Mr. H. G. Burt succeeds Mr. E. W. Winter as General Manager.

Wabash.—Mr. Sidney Emerson has been appointed Chief Engineer, with office at St. Louis.

Texas, Sabine Valley & Northwestern.—Receiver L. Hars has resigned.

Georgia Northern.—Mr. A. McLean has been appointed Superintendent of Motive Power, with office at Pidcock, Ga.

Pittsburgh & Lake Erie.—Mr. J. T. Atwood has been appointed Chief Engineer.

Missouri, Kansas & Texas.—Mr. S. B. Fisher has been promoted to be Chief Engineer, with office at St. Louis.

Eagles Mere Railroad.—Joel H. DeVictor has been elected Vice-President, with office at Philadelphia, Pa., vice John R. T. Ryan.

Peoria, Decatur & Evansville Railway.—H. W. Matters having resigned, W. J. Lewis has been appointed Purchasing Agent, with headquarter at Evansville, Ind.

Lehigh & Lackawanna Railroad.—L. A. Riley has been elected President.

Cleveland, Akron & Columbus Railway.—T. H. Perry is Purchasing Agent, with office at Indianapolis, Ind.

California Eastern.—The following is a list of the officers of the new company: President, R. W. Woodbury; Vice-Presidents, D. G. Scofield and W. N. Byers; Treasurer, I. B. Newton, and Secretary, R. S. Seibert.

St. Louis, Avoyelles & Southwestern Railway.—Hugh J. Fitch has been appointed Receiver of this company.

Columbus, Sandusky & Hocking.—Mr. N. Monsarret has resigned the positions of President and General Manager.

Denver, Lakewood & Golden Railroad.—W. F. R. Mills has been appointed General Superintendent and Purchasing Agent, vice J. B. McCormic, previously General Superintendent.

Marshfield & Southeastern Railway.—Charles H. Grundy has been appointed General Manager, with office at Marshfield, Wis., vice A. A. Hopkins. The Chicago offices are removed to. Nos. 508-9 Roanoke Building.

Southern.—Mr. Josepe H. Green, Master Mechanic at Columbia, S. C., has resigned.

South Carolina & Georgia.—Mr. Joseph H. Green has been appointed Superintendent of Motive Power, with office at Charleston, S. C.

Marietta & North Georgia.—Mr. Joseph McWilliams has been appointed General Manager.

St. Louis & San Francisco.—Mr. B. F. Yoakum is General Manager, vice Mr. H. L. Morrill, resigned.

Fremont, Elkhorn & Missouri Valley.—Mr. George F. Bidwell has been made General Manager, vice H. G. Burt, resigned.

Suffolk & Carolina.—General Manager J. H. Macleary has resigned and Superintendent George L. Barton will perform the duties of the office until further notice.

Employment.

Employment wanted by a man of several years' experience as foreman and general workman. In coach and engine painting. can furnish best of reference as to ability and sobriety. Address AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL.

F. W. DEVOE & CO.'S COLORS AND VARNISHES ARE STANDARDS.

THE ROBERTS SAFETY WATER TUBE BOILER.

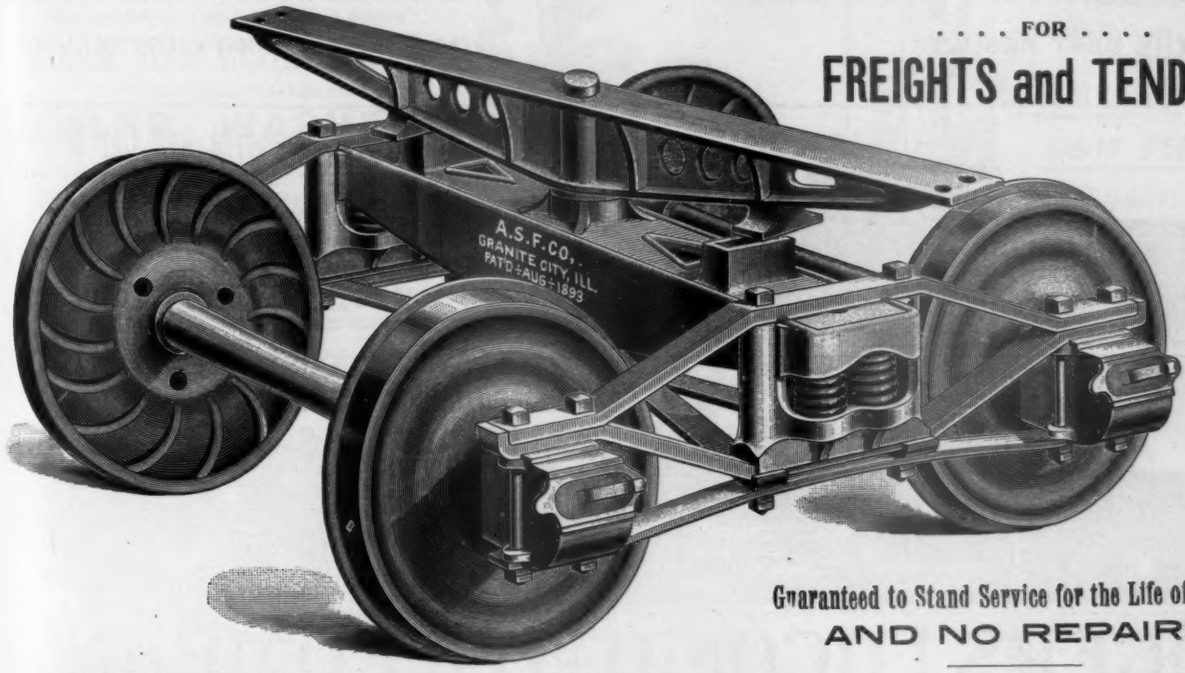
800 IN USE for Naval and Marine Purposes.

Send for Handsome Illustrated Catalogue. . . 39 CORTLANDT STREET, NEW YORK.

THE AMERICAN STEEL TRUCK

. . . . FOR . . . .

FREIGHTS and TENDERS.



MADE OF

Soft Open-Hearth Basic Steel.

Guaranteed to Stand Service for the Life of the Car AND NO REPAIRS.

AMERICAN STEEL FOUNDRY CO., ST. LOUIS, MO., U. S. A.
Send for Descriptive Circular.

Armstrong Tool Holders.

For Turning, Planing and Boring Metals.
50,000 ALREADY IN USE.

SEND FOR CATALOGUE.
ARMSTRONG BROS. TOOL CO.,
No. 98 West Washington St., Chicago.

FREE SAMPLE COPY OF HOME STUDY,

. . . An Elementary Journal for Students Of Mechanics, Electricity, Architecture, Mining, Plumbing, Heating and Ventilation, Steam Engineering, Civil Engineering and Mechanical and Architectural Drawing. Address

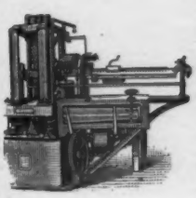
HOME STUDY, Box 985, SCRANTON, PA

BAKER CAR HEATERS

SPECIAL FITTINGS FOR BAKER HEATER WORK.

FLEXIBLE STEEL FIREPROOF HEATERS
FIVE OTHER STYLES.
Single and Double Circulations.

WILLIAM C. BAKER,
(Successor to Baker Heating Co.)
143 LIBERTY ST., NEW YORK.



OLSEN'S Testing Machines

Awarded Medal of Merit at The World's Fair.

FOR TESTING
Iron Specimens, Bridge Materials, Chain, Cement, Wire Springs, Etc.

Hydraulic Presses, Accumulators, Gauges & Pumps.

TINIUS OLSEN & CO., 500 N. 12th St., Philadelphia, Pa.

INVALUABLE

"I have been using one of the Waterman Ideal fountain pens for some time, and take pleasure in saying that I find it an invaluable pocket companion."—WM. McKINLEY.

Try it, and whether you vote for McKinley or not you will vote for our pen every time.

YOUR MONEY BACK IF YOU DON'T.

Ask your stationer, or send for price-list to . . .

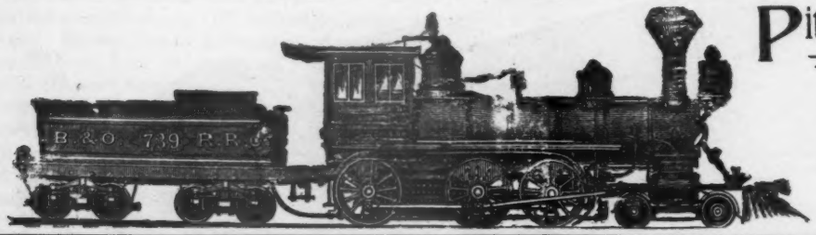
L. E. WATERMAN CO., 155 & 157 Broadway, N. Y.

THOMAS PROSSER & SON,
15 GOLD STREET,
NEW YORK.

KRUPP STEEL TIRES

On Locomotive Driving Wheels and on Steel-Tired Wheels

GIVE THE BEST RESULTS - - - FOR EVERY VARIETY OF SERVICE.



Pittsburgh Locomotive and Car Works,

PITTSBURGH, PA.
Manufacturers of LOCOMOTIVE ENGINES for Broad or Narrow Gauge Roads
From standard designs, or according to specifications, to suit purchasers.
Tanks, Locomotive or Stationary Boilers Furnished at Short Notice.
Wilson Miller, Prest. & Treas.
D. A. Wightman, Supt.

MANCHESTER LOCOMOTIVE WORKS,
Manufacturers of LOCOMOTIVES
AND THE
AMOSKEAG STEAM FIRE ENGINE

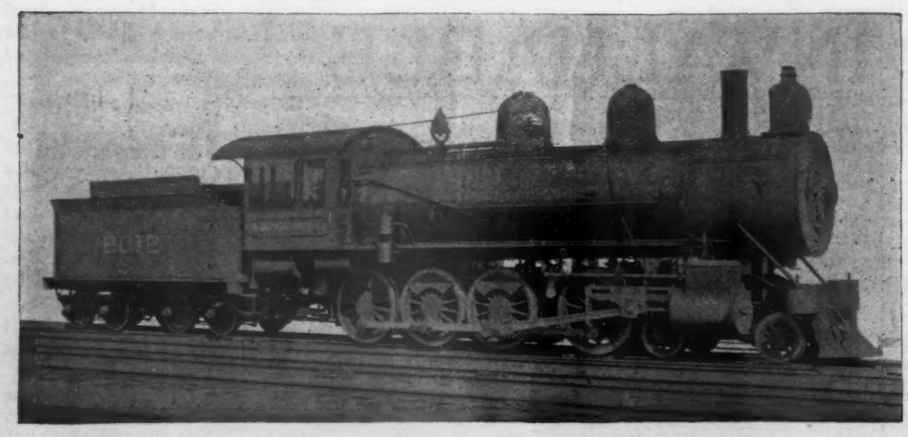
ISRAEL G. WHITNEY, Treasurer, BOSTON
ARETAS BLOOD, Agent, Manchester, N. H.

ROGERS LOCOMOTIVE COMPANY

PATERSON, N. J. *NEW YORK OFFICE, 44 Exchange Place.*

MANUFACTURERS OF LOCOMOTIVE ENGINES AND TENDERS AND OTHER RAILROAD MACHINERY.

R. S. HUGHES, President. G. S. LONGBOTTOM, Sec'y. G. E. HANNAH, Treas. REUBEN WELLS, Supt.



SCHENECTADY
Locomotive • Works,
SCHENECTADY, N. Y.

ESTABLISHED 1848.

Annual Capacity, 450.

EDWARD ELLIS, President.
WM. D. ELLIS, Vice-Pres. and Treasurer.
A. J. PITKIN, Superintendent.
A. P. STRONG, Secretary.

THE NEW "NATHAN"

(See Illustration)

And Monitor Injectors for Locomotives.

"NATHAN"

SIGHT FEED LUBRICATORS.

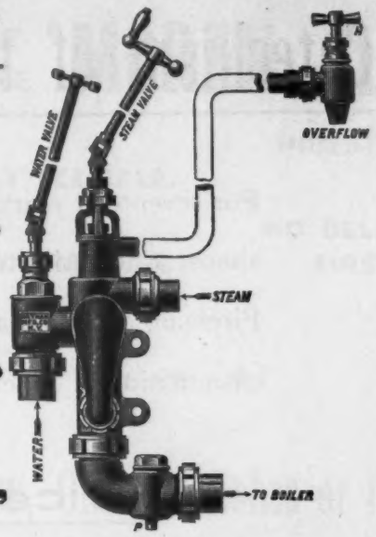
For Locomotive Cylinders and Air Brakes.

STEAM FIRE EXTINGUISHERS

For Switching and Yard Engines.

BOILER WASHERS,

Rod and Guide Oil Cups, etc.



Send for Descriptive Catalogues

NATHAN MFG. CO.,

92 & 94 Liberty St., N. Y.

PNEUMATIC

TRACK SANDING APPARATUS

FOR LOCOMOTIVES.

H. L. LEACH, 176 Huron Ave., N. Cambridge, Mass

The Most Easy Working Locomotives are those that are Equipped with the

DETROIT SIGHT FEED LUBRICATORS

Our Catalogue Tells Why. Send for it.

DETROIT LUBRICATOR CO., Detroit, Mich

BROOKS LOCOMOTIVE WORKS, Dunkirk, N. Y.

BUILDERS OF LOCOMOTIVE ENGINES FOR ANY DESIRED SERVICE FROM OUR OWN DESIGNS OR THOSE OF PURCHASER. Perfect Interchangeability and all Work fully Guaranteed.

COMPOUND LOCOMOTIVES

FOR PASSENGER AND FREIGHT SERVICE.

M. L. HINMAN, Pres. and Treas. R. J. GROSS, Vice-Pres. T. M. HEQUEMBOURG, Sec'y.
F. H. STEVENS, Ass't to the Pres't. DAVID RUSSELL, Supt. H. TANDY, Asst. Supt.

Drawing Materials, Surveying Instruments.

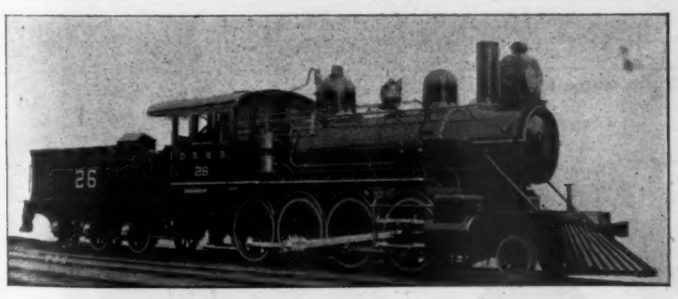
The largest and best-assorted stock in this line. The most complete catalogue. All goods warranted.

Catalogue on Application.

BOUND VOLUMES OF THE

National Car and Locomotive Builder

For 1895. Price $3.



Baldwin Locomotive Works.

Established 1831. ANNUAL CAPACITY, 1,000.

LOCOMOTIVE ENGINES

Adapted to every variety of service and built accurately to standard gauges and template. Like parts of different engines of same class perfectly interchangeable.

Single Expansion and Compound Locomotives; Electrical Locomotives; Broad and Narrow Gauge Locomotives; Mine Locomotives by Steam or Compressed Air; Plantation Locomotives; Noiseless Motors for Street Railways, Etc.

BURNHAM, WILLIAMS & CO.,

Proprietors, PHILADELPHIA, PA.

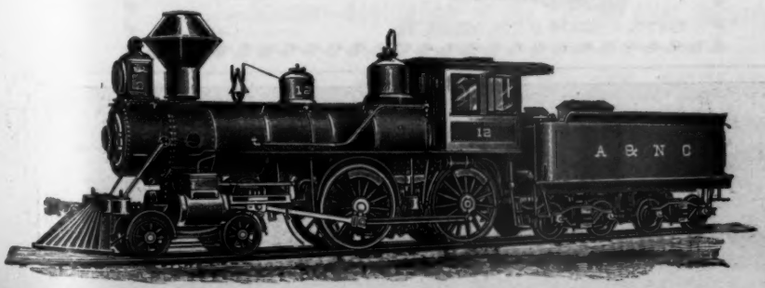
ESTABLISHED 1865.

RICHMOND LOCOMOTIVE & MACHINE WORKS,

RICHMOND, VA.

BUILDERS OF

LOCOMOTIVES



FOR EV RY VARIETY OF SERVICE.

Accurately Made to Gauges and Templates.

P. & B. RUBEROID ROOFING.

It's used for cars, the light, strong, elastic kind, that won't break or tear with the rack of the car. It isn't paper but hair felt saturated with P. & B. water and acid-proof composition. No tar or asphalt in it. We make it in rolls for any length car, sixty inches wide; make most any other width you want. Write for our book.

P. & B. Ruberoid Car Roofing Guaranteed for Ten Years. . .

Then there is the heav er grades used for all kinds of Railroad buildings. It won't rot; it won't run in hot weather and spoil the locks of your building. It won't cost much; it will suit you; it will stand locomotive fumes and gases; it needs less attention than any other roofing made. We've just issued the most comp'ete sample book and catalogue for Railroad officials ever printed. Send for it.

Then there is P. & B. Insulating Papers for Fruit, Dairy and Refrigerator Cars, in use for over ten years.

THE STANDARD PAINT CO.

81-83 JOHN STREET, NEW YORK.

RALPH L. SHAINWALD, PRESIDENT.
FRANK S. DE RONDE, GEN'L SALES AGENT.

Catechism of the Locomotive.

For seventeen years it has been the best authority and almost a necessity to every Locomotive Engineer and Fireman, and on many railroads it is the standard for examination of Firemen for promotion.

Price, $3.50

For Sale by . . . . .

American Engineer, Car Builder and Railroad Journal,

MORSE BUILDING, NEW YORK CITY.

Protective Paint

affords perfect protection for wood and all metals against the weather. Is not affected by heat or cold, and will not peel or crack IROWN Paint will absolutely prevent decay and corrosion, and will last for years. IROWN Paint contains no mineral or rubber, and is positively unequalled. We will furnish it in any quantity, in black, red or maroon.

WRITE US FOR PARTICULARS.

THE UNIVERSAL PROTECTIVE PAINT CO., Room 10, 77 So. Clark St., CHICAGO, ILL.

"SHIMER" Matcher Heads

work well in hard, cross-grained and knotty lumber,

Make Smooth Edges

save more time, labor, material, and

Do Better Work

than any others.

YOU OUGHT TO TRY A SET.

Send for Catalogue and Measurement Card.

SAMUEL J. SHIMER & SONS, MILTON, PA.

THE BROWN HOISTING AND CONVEYING MACHINE CO. CLEVELAND, O.

MACHINERY FOR HANDLING COAL AND ORE.

CRANES

NEW YORK. HAVEMEYER. BLDG.
PITTSBURG. CARNEGIE. BLDG.
CHICAGO. MARQUETTE. BLDG.

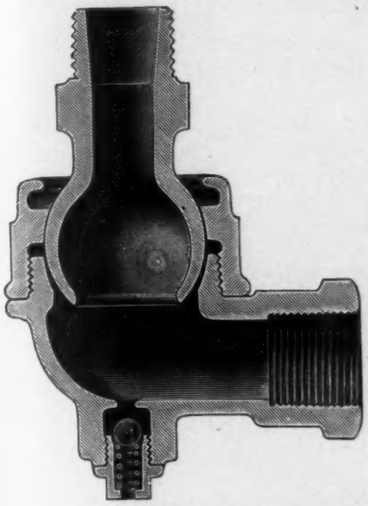
ADVANTAGES OF THE MORAN FLEXIBLE JOINT.

ALL METAL CONNECTION,
ABSOLUTELY FLEXIBLE.

INDESTRUCTIBLE
SHORT OF WRECK.

POSITIVELY STEAM TIGHT
UNDER ANY PRESSURE.

NO DELAYS, NO REPAIRS,
FIRST COST IS THE ONLY COST

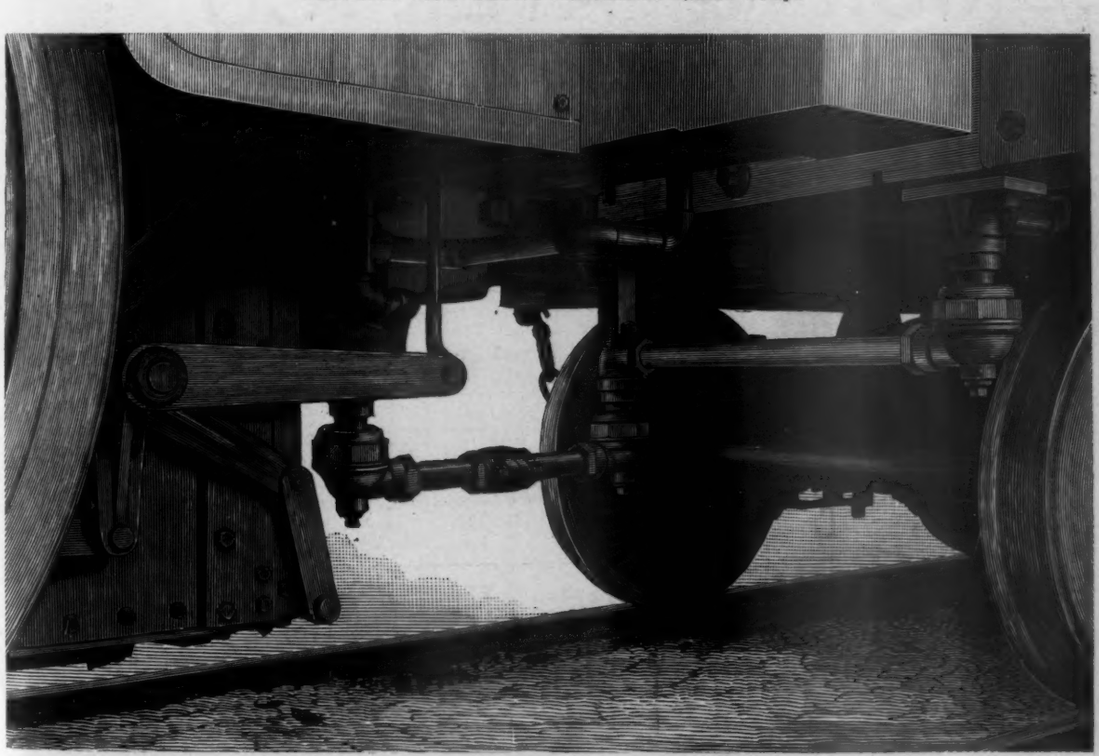


★ ★ ★

Steam, Oil, Hot Ashes or Dirt
Does Not Affect Its Life.

★ ★ ★

Above Cuts Represent Special Joint for Steam Heating Connection Between Engine and Tender.
Sectional View Shows Automatic Relief Trap.



Showing Application of the Special Joint Between Engine and Tender.

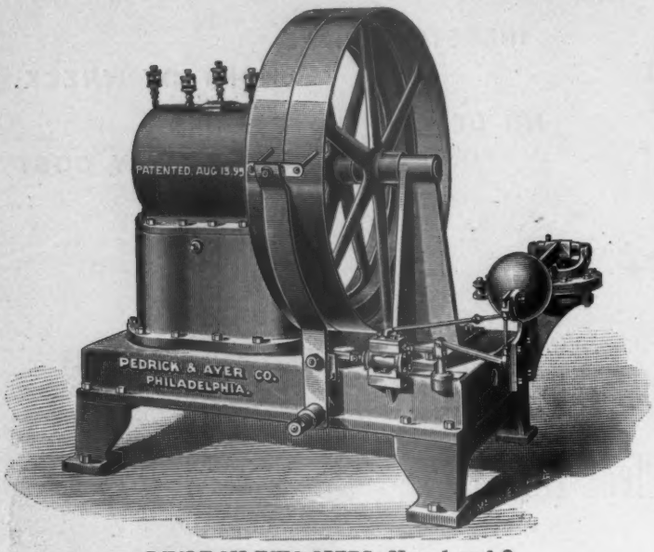
... PARTICULARS ON APPLICATION. ..

MORAN FLEXIBLE STEAM JOINT CO. (Inc'd)

(HENRY U. FRANKEL, President),

149 THIRD STREET, LOUISVILLE, KY.

AUTOMATIC COMPOUND BELT AIR COMPRESSOR.



BUILT IN TWO SIZES—Nos. 1 and 2.

Designed for Shop use to furnish Air for Pneumatic Tools. Self-regulating, automatically stopping and starting as pressure varies, using very little power. Occupies small space. As durable as is possible to make of steel and cast iron. 120 in successful operation. If interested write for Form 17 Novelty.

AIR HOSE COUPLINGS WITH SELF-CLOSING VALVE.

FULL SIZE.

Made in three sizes—½, ¾ and 1 inch. A very serviceable and quick coupling. When disconnected the flow of air is stopped. A very desirable device for connecting hoists that are to be used in different places, as the load can be raised and disconnected and the hoist or other tool moved away. By having several pendant hose with these fixtures, one hoist will serve in many places.

WRITE FOR FORM NO. 13 NOVELTY.

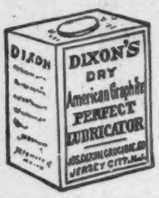
NEW CATALOGUE JUST ISSUED. . .

AIR LIFTS.

Cut represents No. 2 Built in three styles: Nos. 1, 2, 3. No. 1 style for ordinary lifting. No. 2 style has load retainer and can be adjusted for exact heights. No. 3 has an additional releasing valve for foundry work. **Write for Form No. 6 Novelty.**

PEDRICK & AYER CO.,

STATION S, PHILADELPHIA, PA., U. S. A.



It has been demonstrated beyond question that DIXON'S PURE FLAKE GRAPHITE

Is as necessary to the proper equipment of an engine as a monkey wrench or an oil can. It positively saves engine and valve oil, and prevents and cures hot pins and bearings.

SEND FOR SAMPLE AND TESTIMONY OF EXPERTS. JOS. DIXON CRUCIBLE CO., JERSEY CITY, N. J.

WESTINGHOUSE ELECTRIC AND MANUFACTURING CO.,

. . . MANUFACTURERS OF . . .

PITTSBURGH, PA.

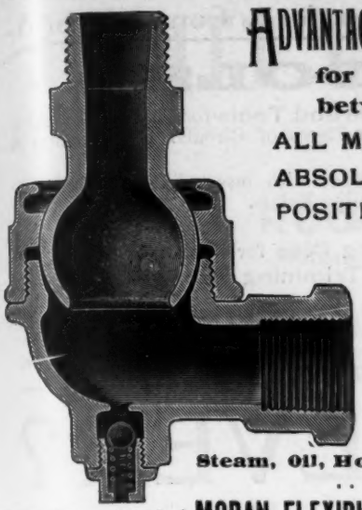
Standard Systems for Electric Light and Power Distribution in Cities, Factories, Mills and Mines. . . . . .

The Tesla Polyphase Alternating System for Electrical Transmission by which POWER, INCANDESCENT and ARC LIGHTING may be supplied from THE SAME CIRCUIT. . . . . .

THE WESTINGHOUSE ELECTRIC RAILWAY SYSTEM, which is the MOST DURABLE, ECONOMICAL and EFFICIENT on the MARKET. . .

NEW YORK, 120 Broadway.
BOSTON, Exchange Building.
CHICAGO, New York Life Building.
TACOMA, WASH., 102 S. 10th Street.
PITTSBURG, Westinghouse Building.
BUFFALO, Erie County Bank Building.
PHILADELPHIA, Girard Building.
ST. LOUIS, American Central Building.
CHARLOTTE, N. C., 35-38 College Street.
SYRACUSE, N. Y., Bastable Building.
SAN FRANCISCO, Mills Building.
WASHINGTON, D. C., 1333 F Street N

For Canada, address: **AHEARN & SOPER, OTTAWA, CANADA.**



Sectional View of Standard R. R. Joint, showing Automatic Relief Trap.

ADVANTAGES OF THE MORAN FLEXIBLE JOINT

for a Steam Heating Connection between Engine and Tender. . .

ALL METAL CONNECTION,
ABSOLUTELY FLEXIBLE,
POSITIVELY STEAM TIGHT
UNDER ANY PRESSURE,
INDESTRUCTIBLE,
SHORT OF WRECK,
NO DELAYS, NO REPAIRS,
FIRST COST IS THE ONLY COST.

Steam, Oil, Hot Ashes or Dirt does not Affect Its Life.

. . . PARTICULARS ON APPLICATION. . . .

MORAN FLEXIBLE STEAM JOINT CO. (Inc'd), HENRY U. FRANKEL President,
149 THIRD STREET, LOUISVILLE, KY.

INDEX TO ADVERTISERS.—*Continued.*

Vises:
Merrill Bros., Brooklyn, N. Y.

Washers:
The Milton Mfg. Co., Milton, Pa.

Water Columns:
Reliance Gauge Co., Cleveland, O.

Water Tanks:
Automatic Water Tank Co., New York, N. Y.

Water-Tube Boilers:
Almy Water-Tube Boiler Co., Providence, R. I.
Abendroth-Root Mfg. Co., New York, N. Y.
L. Boyer's Sons, New York, N. Y.
Roberts Safety, W. J. B. Co., New York.

Wells Light:
Wells Light Mfg. Co., New York City.

Wire and Wire Rope:
Trenton Iron Co., Trenton, N. J.

Wire Fences:
Page Woven Wire Fence Co., Adrian, Mich.

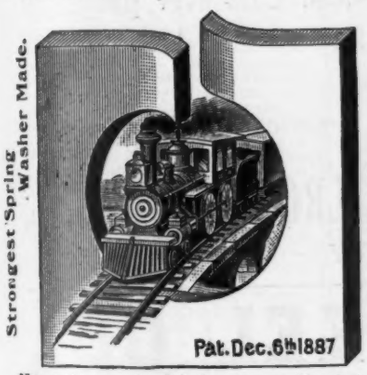
Wood Preserving:
Lehigh Valley Creosoting Wks., NewYork, N.Y.

Wood-Working Machinery:
Shimer, Samuel J. & Sons, Milton, Pa.

Wrench:
Coes Wrench Co., Worcester, Mass.
Wright Wrench Co., Worcester, Mass

Wrought Iron Pipe:
Crane & Co., Chicago, Ill.

EUREKA NUT LOCK.



Never known to fail in use on Track-joints, Bridges, Engines, Cars, Vehicles, etc.
All sizes made, both for iron and woodwork.
More reliable than double nuts or cotter pins.

—ALSO—

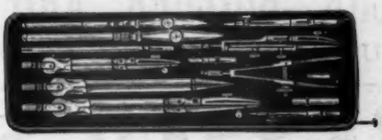
Full Line Standard Track Tools.

EUREKA NUT LOCK CO., Pittsburgh, Pa.

F. WEBER & CO.,

Engineers' and Draughtsmen's Supplies.

Sole Agents for Riefler's Celebrated Round System Drawing Instruments, and Ott's Pantographs and Planimeters.



Drawing and Tracing Papers, Blue Print Papers and Linen, Etc.

1125 Chestnut St., Philadelphia.

BRANCH HOUSES:
ST. LOUIS, MO. BALTIMORE, MD.

PURDUE • UNIVERSITY,

LA FAYETTE, INDIANA.
Courses in Mechanical Engineering, Electrical Engineering, Civil Engineering.
Extensive Laboratories. Fine Equipments.
Catalogue sent on application.

Railway Car Construction

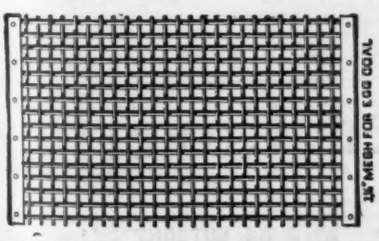
Price $3.00.

American Engineer Car Builder & Railroad Journal

Morse Building, New York

"HUNT" SYSTEM
COAL HANDLING MACHINERY.

COAL POCKET WOVEN SCREEN.

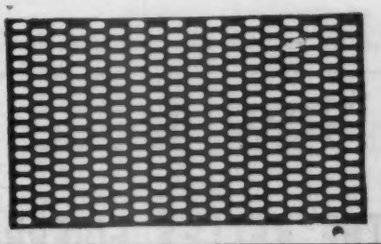


Coal Pockets designed and equipped with the most economical machinery.

Plans and Estimates furnished on application.
Send for Catalogue.

C. W. HUNT COMPANY,
45 Broadway, N. Y.

COAL POCKET PLATE SCREEN.



Automatic Water Tanks
SAVE ALL PUMPING-EXPENSE
at R. R. Water Stations.

1,000 GALLONS PER MINUTE.

THE AUTOMATIC WATER TANK CO.,
143 Liberty Street, New York.

THE PRATT & WHITNEY CO., Hartford, Conn., U. S. A.

FINE MACHINE TOOLS.

Single and Double Head Milling Machines, used as substitutes for Planers for Heavy and Rapid Cutting in Cast and Wrought Iron and Steel.

Metal Band Sawing Machines for Cutting Sprues from Brass Castings.

Gages and Small Tools for General Machine Work.

Automatic Weighing Machines, a revolution in weighing and measuring.

Turret Head Machines and Tools for Turning, Forming and Threading Irregular Pieces of Circular Cross-section in Brass, Iron and Steel.

Milling Cutters, Holders, with inserted Cutters for Turning, Shaping and Threading Metals.

Spiral Shear Punches.

Forging and Trimming Dies for all classes of work.

Drop Hammers and Trimming Presses.

BUCK & HICKMAN, 280 Whitechapel Road, London, E. CHAS. CHURCHILL & CO., Ltd., 21 Cross St., Finsbury, London, E. C.
F. G. KREUTZBERGER, FENWICK FRERES & CO., 21 Rue Martel, Paris.

CHICAGO: 42 and 44 South Clinton St. **BOSTON: 281 Franklin St.** **NEW YORK: 123 Liberty St.**

Are you for ..... **GOLD or SILVER?**

. . . **We take payment in either.** . . .

GREENBACKS

are also accepted to the amount of **$3.00** for the best book on American Cars ever published

200 PAGES. ∴ 500 ENGRAVINGS.

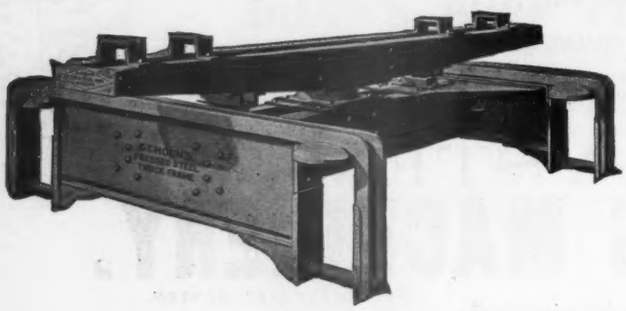
By WILLIAM VOSS.

Full Working Drawings of every style of car now used on American Railroads.

AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL,

140 NASSAU STREET, NEW YORK CITY.

SCHOEN PRESSED STEEL CO.,



——MANUFACTURERS OF——

Truck Frames and Bolsters FOR CARS.

General Office and Works: PITTSBURGH, PA.

PHILADELPHIA: Betz Building. **CHICAGO:** Monadnock Building. **NEW YORK:** 100 Broadway.

A New Locomotive Boiler Covering.

THE KELLEY FIREPROOF LAGGING CASING, WITH OR WITHOUT FILLING,

GIVES A SMOOTH SURFACE FOR JACKETING.

These Casings are made in sections and any desired length and width, either flat or curved.

They can be removed and replaced without injury. They are strong; easily adjusted without countersinking.

The cost is one-half that of other sectional coverings.

Samples and prices sent upon application. Correspondence solicited. Address . . . .

THE KELLEY CO.,
MINERAL POINT, WIS.

JOWITT CARBONIZED FELT COMPANY,

ESTABLISHED 1880.

MANUFACTURERS OF

ROOFING AND BUILDING PAPERS.

Mills: Stanley, N. J. 66 MAIDEN LANE, NEW YORK.

W. G. WINANS, President. M. H. WINANS, Treasurer.
H. H. JOWITT, Vice-Pres. J. A. SMITH, Secretary.

Ready Roofings. Carbonized Felts. Building Papers, All Kinds.
Waterproof Carbolized Moth Paper. Roofing Materials. Paving Materials.
Coal Tar, Pitch, Rosin, Naval Stores. Refined Asphalt.
Asphalt Roofing Materials. Asphalt Coatings.

CORRESPONDENCE SOLICITED.

ALPHABETICAL INDEX TO ADVERTISERS.

	PAGE.
Abendroth & Root Mfg. Co	7
Acme Machinery Co	15
Ætna Standard Iron & Steel Co	46
Aitchison Perforated Metal Co	42
Ajax Metal Co	46
Albro Co., The E. D	14
Allen Paper Car Wheel Co	10
Allis, The Edward P. Co	6
Allison Mfg. Co., The	9
Almy Water Tube Boiler Co	6
Alteneder & Sons, Theodore	23
American Heat Insulating Co	7
American Steel Foundry Co	23
Armstrong Bros. Tool Co	23
Armstrong Mfg. Co	17
Ashton Valve Co	22
Automatic Water Tank Co	19
Babcock & Wilcox Co	4
Baker, W. C	23
Baldwin Locomotive Works	25
Bangs, E. D., Oil Cup Co	17
Bass Foundry & Machine Works	11
Becker Mfg. Co., The John	16
Bement Miles & Co	12
Big Four Route	10
Billmeyer & Small	9
Boies Steel Wheel Co	8
Boston & Albany R. R	32
Boston & Maine R. R	17
Boyer's, L., Sons	6
Boyer Ry. Speed Recorder Co	7
Bradley Car Works	9
Bridgeport Safety Emery Wheel Co	8
Brooks Locomotive Works	25
Brown Hoisting & Conveying Machine Co	26
Bruner, Sprague & Co	3
Bushnell Mfg. Co	1
Cady Mfg. Co	9
Cameron, A. S., Steam Pump Co	7
Cambria Iron Co	22
Carbon Steel Co	44
Carlisle Mfg. Co	9
Central Iron & Steel Co	17
Chester Steel Castings Co	30
Chicago Grain Door Co	17 and 30
Chicago Pneumatic Tool Co	15
Cincinnati Screw & Tap. Co	1
Clayton Air Compressor Works	1
Cleveland City Forge & Iron Co	1
Cleveland Ship Building Co	46
Cleveland Twist Drill Co	1
Connelly, J. T	32
Coes Wrench Co	30
Continental Iron Works	5
Contractors' Plant Mfg. Co	5
Correspondence School of Technology	42
Crane Co	38
Crook, W. A., & Bros. Co	18
Crosby Steam Gage Valve Co	7
Devoe, F. W., & Co	1 and 23
D'Este & Seeley Co	2
Diamond Machine Co	30
Dickerman Emery Wheel Co	8
Detroit Graphite Co	30
Detroit Lubricator Co	25
Dixon, Jos., Crucible Co	28
Dudgeon, Richard	5
Eureka Nut Lock Co	19
Ewald Iron Co	34
Faessler, J.	30
Falls Hollow Staybolt Co	40
Felton, Sibley & Co	9
Ferracute Machine Co	30
Finished Steel Co	34
Fitchburg R. R. Co	34
Fowler, Geo. L	42
Fox Solid Pressed Steel Co	4
Galena Oil Works (Limited)	7
Goetze, Otto	22 and 42
Gould Coupler Co	38
Gould & Eberhardt	18
Haesler, C. H., & Co	32
Hale & Kilburn Mfg. Co	14
Hammett, M. C	30 and 46
Hancock Inspirator Co	26
Harlan & Hollingsworth Co	8
Harrington & King Perforating Co	1
Harland, W. M., & Sons	46
Hartford Woven Wire Mattress Co	8
Hartshorn, Stewart	16
Howard Iron Works	10
Howson & Howson	1
Hunt Co., C. W	19
Hutchins & Sons, C. B	46
Indian & Eastern Engr	40
International Correspondence Schools	23
Iron Clad Paint Co	42
Jackson, Sharp & Co	8
Jackson & Woodwin Mfg. Co	8
Jowitt Carbonized Felt Co	21
Jones & Lamson Machine Co	30
Jones, B. M. & Co	1
J. H. Bass	11
Keasbey & Mattison Co	2
Kelley Co	20
Ketcham, Chas. F., & Co	10
Keuffel & Esser Co	25
Krupp (Prosser & Son)	9 and 24
Laborers Inst. Pub. Co	16
Lake Bros	16
Lake Shore & Mich. Southern Ry Co	38
Latrobe Steel Works	10
Leach, H. L	25
Lenoir Car Co	12
Lenoir Foundry Co	11
Leonard & Ellis	8
Leslie, J. S	20
Lehigh Valley Creosoting Works	8
Lidgerwood Mfg. Co	3
Link-Belt Engineering Co	6
Lobdell Car Wheel Co	10
Long & Allstatter Co	40
Magnolia Metal Co	1
Manchester Locomotive Works	24
Mason, Volney W., & Co	15
McKeown, H. J	42
Merrill Bros	1
McConway & Torley Co	44
Mianus Electric Co	16
Milton Mfg. Co., The	16
Monon Route	42
Moore Mfg. & Foundry Co	46
Moran Flex. Steam Joint Co. (Inc'd)	19
Morse Twist Drill Co	18
Moyes, L. M	6
Mundt & Sons, Chas	16
Mundy, J. S	10
National Brass Mfg. Co	40
National Hollow Brakebeam Co	22
National Machinery Co	26
National Malleable Castings Co	12
Nathan Mfg. Co	25
Newburgh Ice Machine & Engine Co	6
New York, N. Haven & Hartford R.R	40
New York & New England R. R. Co	18
Niagara Spray Ejector	10
North Carolina Car Co	13
Norton, A. O	46
Norwalk Iron Works	36
Olsen, Tinius & Co	23
Page Woven Wire Fence Co	5
Pedrick & Ayer	28
Peerless Rubber Co	4
Pennsylvania R. R	38
Pennsylvania Steel Co	9
Phosphor Bronze Smelting Co	7
Photo Engraving Co	18
Pittsburgh Locomotive & Car Works	24
Pittsburgh Testing Laboratory, Ltd	22
Pettingell, Frank H	36
Poole, R., & Son Co	3
Port Chester Bolt & Nut Co	22
Pratt & Lambert	1
Pratt & Whitney Co	20
Prosser, Thos., & Son	9 and 24
Prentiss Clock Improvement Co	34
Purdue University	19
Q. & C. Co	22
Queen & Crescent Route	32
Ramapo Wheel & Foundry Co	10
Rand Drill Co	32
Reliance Gauge Co	10
Rensselaer P. Institute	22
Richards, I. P	23
Richmond Locomotive & Machine Co	25
Riehle Bros. Testing Machine Co	5
Roberts Safety Water Tube Boiler	23
Roberts, Throp & Co	23
Rogers Locomotive Wks	24
Ross Valve Co	7
Russell Wheel and Foundry Co	1
Safety Car Heating & Lighting Co	13
Scarritt Furniture Co	14
Schenectady Locomotive Works	24
Schoen Pressed Steel Co	20
Scott, Chas., Spring Co	13
Sellers, William, & Co	2
Servoss, R. D	32
Shaw, Willis	7
Sheffield Car Co	1
Shimer, Sam'l J., & Sons	26
Shoenberger Steel Co	46
Signal Oil Works	10
Smith, Ed., & Co	22
Sooysmith & Co	8
Standard Coupler Co	22
Standard Paint Co	26
Sterling Emery Wheel Mfg. Co	18
Stow Mfg. Co	32
St. Louis Car Wheel Co	11
Trenton Iron Co	4
Thurman Fuel Oil Burner Co	32
Universal Protective Paint Co	26
U. S. Metallic Packing Co	3
Valentine & Co	4
Vanderbilt & Hopkins	32
Vulcan Iron Works Co	15
Warren Chemical Mfg. Co	15
Washington Patent Agency	9
Watson, H. F., Co	18
Watson & Stillman	5
Weber, F., & Co	20
Weir Frog Co	32
Wellington, Henry W	9
Wells Light	34
Westinghouse Air Brake Co	43
Westinghouse Electric and Mfg. Co	20
Whiting Fd'ry Equipment Co	46
Wiley & Russell Mfg. Co	34
Woods, W. Dewees, Co	16
Worcester Machine Screw Co	9
Wright Wrench Co	30

RAILWAY CAR CONSTRUCTION,

By WILLIAM VOSS.

200 Pages. Upward of 500 Engravings. Price, $3.

AMERICAN ENGINEER, CAR BUILDER AND RAILROAD JOURNAL, Morse Building, New York.

H. S. BURKHARDT, President. E. B. LEIGH, V. P. and Gen. Man.
CHICAGO RAILWAY EQUIPMENT CO., Lessee.

A PERFECTLY CONSTRUCTED METAL BRAKE BEAM.
The Cheapest, Lightest and Most Durable.
Now Standard on a Large Number of Roads Throughout the Country.
CORRESPONDENCE SOLICITED.
General Office and Works:
40th and Hopkins Sts., Chicago.
CITY OFFICE: 514 Western Union Bldg., Chicago. NEW YORK OFFICE: Room 118, 29 Broadway. FREDERICK G. ELY, Eastern Agent.

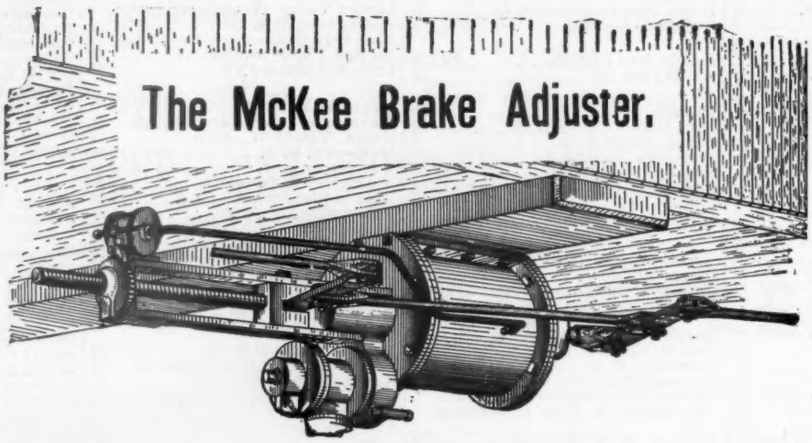
POP VALVES and STEAM GAGES
MERITS AND REPUTATION
UNEQUALLED.
The Ashton Valve Co., Boston, Mass.

CAMBRIA STEEL.
Heavy Rails, Light Rails and Rail Fastenings,
STEEL CAR AXLES,
Steel Car Channels, Street Rails.
Address: CAMBRIA IRON CO.,
S. W. Cor. 15th and Market Sts., Philadelphia, Pa.
(Opposite Pa. R. R. Station.)
[Works: Johnstown, Pa.]
Chicago Office, Western Union Building.
New York Offices—For Rails and Axles, 33 Wall St.
For Structural Steel, 100 Broadway.

WHY does the McKee Brake Adjuster succeed where all others fail . . . ?
BECAUSE
BECAUSE
It insures predetermined travel regardless of deflection in Brake Gear. . .

OUR FOLDER
Tells the Whole Story.
: SEND FOR IT. :

The McKee Brake Adjuster.



OUR GUARANTEE
Insures Perfect Satisfaction.
Each Adjuster Warranted.

New York Branch: 100 Broadway.
THE Q & C COMPANY,
700-7 Western Union Bldg., CHICAGO, ILL.

EDWARD·SMITH·AND·COMPANY·
VARNISH·MAKERS·AND·COLOR·GRINDERS·
No. 45 BROADWAY, ·NEW·YORK·

RENSSELAER POLYTECHNIC INSTITUTE,
TROY, N. Y.
A School of Engineering.
ESTABLISHED 1824.
Send for a Catalogue.

PITTSBURG TESTING LABORATORY, Limited.
GEO. H. CLAPP, Chairman. ALFRED E. HUNT, Vice-Chairman and Treas
325 Water St., Pittsburg, Pa.
SPECIALTIES: Inspection of Rails and of Material for Bridges and other Structures, Steam Boilers, Locomotives, Cars, etc. Inspection of Shop Work and Erection at Bridge Site. Chemical Analysis and Physical Tests of all kinds.
Agens for Tinius, Olsen & Co.'s Testing Machines; Thacher' Slide Rules.

Port Chester Bolt and Nut Company,

PORT CHESTER, N. Y.
MANUFACTURERS OF
Cold Punched, Chamfered and Trimmed, Case Hardened, and Semi-Finished
NUTS.
Also BOLTS, RIVETS and WASHERS.
NUTS FOR RAILROADS, CAR BUILDERS', LOCOMOTIVE BUILDERS' AND MACHINISTS' USE A SPECIALTY.
Correspondence Solicited.

IMPROVED "STANDARD" COUPLER.
Manufactured by
GEO. A. POST, President.
A. P. DENNIS, Sec'y & Treas.
STANDARD COUPLER CO., 26 Cortlandt St., N. Y.
FORGED STEEL KNUCKLE AND LOCKING PIN. Only Three Parts. No Pivot Pin.
SIMPLEST in DESIGN. STRONGEST in SERVICE. Thousands in Use. M. C. B. Type.